

JOURNAL OF THE ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

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Edited by

FRANK CRISP, LL.B., B.A.,

One of the Secretaries of the Society

and a Vice-President and Treasurer of the Linnean Society of London ;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

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AND

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Lecturer on Zoology in the School of Medicine, Edinburgh,

FELLOWS OF THE SOCIETY.

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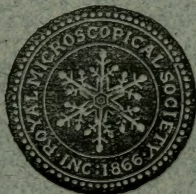
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Numerical Aperture. ($n \sin u = a$)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2 .)	Penetrating Power. ($\frac{1}{a}$)
	Air ($n = 1.00$.)	Water ($n = 1.33$.)	Homogeneous Immersion ($n = 1.52$.)	White Light. ($\lambda = 0.5269 \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0.4861 \mu$, Line F.)	Photography. ($\lambda = 0.4000 \mu$, near Line λ .)		
1.52	180° 0'	146,543	158,845	193,037	2.310	.658
1.51	166° 51'	145,579	157,800	191,767	2.280	.662
1.50	161° 23'	144,615	156,755	190,497	2.250	.667
1.49	157° 12'	143,651	155,710	189,227	2.220	.671
1.48	153° 39'	142,687	154,665	187,957	2.190	.676
1.47	150° 32'	141,723	153,620	186,687	2.161	.680
1.46	147° 42'	140,759	152,575	185,417	2.132	.685
1.45	145° 6'	139,795	151,530	184,147	2.103	.690
1.44	142° 39'	138,830	150,485	182,877	2.074	.694
1.43	140° 22'	137,866	149,440	181,607	2.045	.699
1.42	138° 12'	136,902	148,395	180,337	2.016	.704
1.41	136° 8'	135,938	147,350	179,067	1.988	.709
1.40	134° 10'	134,974	146,305	177,797	1.960	.714
1.39	132° 16'	134,010	145,260	176,527	1.932	.719
1.38	130° 26'	133,046	144,215	175,257	1.904	.725
1.37	128° 40'	132,082	143,170	173,987	1.877	.739
1.36	126° 58'	131,118	142,125	172,717	1.850	.735
1.35	125° 18'	130,154	141,080	171,447	1.823	.746
1.34	123° 40'	129,189	140,035	170,177	1.796	.741
1.33	..	180° 0'	122° 6'	128,225	138,989	168,907	1.769	.752
1.32	..	165° 56'	120° 33'	127,261	137,944	167,637	1.742	.758
1.31	..	160° 6'	119° 3'	126,297	136,899	166,367	1.716	.763
1.30	..	155° 38'	117° 35'	125,333	135,854	165,097	1.690	.769
1.29	..	151° 50'	116° 8'	124,369	134,809	163,827	1.664	.775
1.28	..	148° 42'	114° 44'	123,405	133,764	162,557	1.638	.781
1.27	..	145° 27'	113° 21'	122,441	132,719	161,287	1.613	.787
1.26	..	142° 39'	111° 59'	121,477	131,674	160,017	1.588	.794
1.25	..	140° 3'	110° 39'	120,513	130,629	158,747	1.563	.800
1.24	..	137° 36'	109° 20'	119,548	129,584	157,477	1.538	.806
1.23	..	135° 17'	108° 2'	118,584	128,539	156,207	1.513	.813
1.22	..	133° 4'	106° 45'	117,620	127,494	154,937	1.488	.820
1.21	..	130° 57'	105° 30'	116,656	126,449	153,668	1.464	.826
1.20	..	128° 55'	104° 15'	115,692	125,404	152,397	1.440	.833
1.19	..	126° 58'	103° 2'	114,728	124,359	151,128	1.416	.840
1.18	..	125° 3'	101° 50'	113,764	123,314	149,857	1.392	.847
1.17	..	123° 13'	100° 38'	112,799	122,269	148,588	1.369	.855
1.16	..	121° 26'	99° 29'	111,835	121,224	147,317	1.346	.862
1.15	..	119° 41'	98° 20'	110,872	120,179	146,048	1.323	.870
1.14	..	118° 0'	97° 11'	109,907	119,134	144,777	1.300	.877
1.13	..	116° 20'	96° 2'	108,943	118,089	143,508	1.277	.885
1.12	..	114° 44'	94° 55'	107,979	117,044	142,237	1.254	.893
1.11	..	113° 9'	93° 47'	107,015	115,999	140,968	1.232	.901
1.10	..	111° 36'	92° 43'	106,051	114,954	139,698	1.210	.909
1.09	..	110° 5'	91° 38'	105,087	113,909	138,428	1.188	.917
1.08	..	108° 36'	90° 34'	104,123	112,864	137,158	1.166	.926
1.07	..	107° 8'	89° 30'	103,159	111,819	135,888	1.145	.935
1.06	..	105° 42'	88° 27'	102,195	110,774	134,618	1.124	.943
1.05	..	104° 16'	87° 24'	101,231	109,729	133,348	1.103	.952
1.04	..	102° 53'	86° 21'	100,266	108,684	132,078	1.082	.962
1.03	..	101° 30'	85° 19'	99,302	107,639	130,808	1.061	.971
1.02	..	100° 10'	84° 18'	98,338	106,593	129,538	1.040	.980
1.01	..	98° 50'	83° 17'	97,374	105,548	128,268	1.020	.990
1.00	180° 0'	97° 31'	82° 17'	96,410	104,503	126,998	1.000	1.000
0.99	168° 48'	96° 12'	81° 17'	95,446	103,458	125,728	.980	1.010
0.98	157° 2'	94° 56'	80° 17'	94,482	102,413	124,458	.960	1.020
0.97	151° 52'	93° 40'	79° 18'	93,518	101,368	123,188	.941	1.031
0.96	147° 29'	92° 24'	78° 20'	92,554	100,323	121,918	.922	1.042
0.95	143° 36'	91° 10'	77° 22'	91,590	99,278	120,648	.903	1.053
0.94	140° 6'	89° 56'	76° 24'	90,625	98,233	119,378	.884	1.064
0.93	136° 52'	88° 44'	75° 27'	89,661	97,188	118,108	.865	1.075
0.92	133° 51'	87° 32'	74° 30'	88,697	96,143	116,838	.846	1.087
0.91	131° 0'	86° 20'	73° 33'	87,733	95,098	115,568	.828	1.099
0.90	128° 19'	85° 10'	72° 36'	86,769	94,053	114,298	.810	1.111
0.89	125° 45'	84° 0'	71° 40'	85,805	93,008	113,028	.792	1.124
0.88	123° 17'	82° 51'	70° 44'	84,841	91,963	111,758	.774	1.136

APERTURE TABLE—continued.

Numerical Aperture. ($n \sin u = a.$)	Corresponding Angle (2 u) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. ($a^2.$)	Pene- trating Power. ($\frac{1}{a}$)
	Air ($n = 1.00.$)	Water ($n = 1.33.$)	Homogeneous Immersion ($n = 1.62.$)	White Light. ($\lambda = 0.5269 \mu,$ Line E.)	Monochromatic (Blue) Light. ($\lambda = 0.4861 \mu,$ Line F.)	Photography. ($\lambda = 0.4000 \mu,$ near Line h.)		
0.87	120° 55'	81° 42'	69° 49'	83,877	90,918	110,488	.757	1.149
0.86	118° 38'	80° 34'	68° 54'	82,913	89,873	109,218	.740	1.163
0.85	116° 25'	79° 37'	68° 0'	81,949	88,828	107,948	.723	1.176
0.84	114° 17'	78° 20'	67° 6'	80,984	87,783	106,678	.706	1.190
0.83	112° 12'	77° 14'	66° 12'	80,020	86,738	105,408	.689	1.205
0.82	110° 10'	76° 8'	65° 18'	79,056	85,693	104,138	.672	1.220
0.81	108° 10'	75° 3'	64° 24'	78,092	84,648	102,868	.656	1.235
0.80	106° 16'	73° 58'	63° 31'	77,128	83,603	101,598	.640	1.250
0.79	104° 22'	72° 53'	62° 38'	76,164	82,558	100,328	.624	1.266
0.78	102° 31'	71° 49'	61° 45'	75,200	81,513	99,058	.608	1.282
0.77	100° 42'	70° 45'	60° 52'	74,236	80,468	97,788	.593	1.299
0.76	98° 56'	69° 42'	60° 0'	73,272	79,423	96,518	.578	1.316
0.75	97° 11'	68° 40'	59° 8'	72,308	78,378	95,248	.563	1.333
0.74	95° 28'	67° 37'	58° 16'	71,343	77,333	93,979	.548	1.351
0.73	93° 46'	66° 34'	57° 24'	70,379	76,288	92,709	.533	1.370
0.72	92° 6'	65° 32'	56° 32'	69,415	75,242	91,439	.518	1.389
0.71	90° 28'	64° 32'	55° 41'	68,451	74,197	90,169	.504	1.408
0.70	88° 51'	63° 31'	54° 50'	67,487	73,152	88,899	.490	1.429
0.69	87° 16'	62° 30'	53° 59'	66,523	72,107	87,629	.476	1.449
0.68	85° 41'	61° 30'	53° 9'	65,559	71,062	86,359	.462	1.471
0.67	84° 8'	60° 30'	52° 18'	64,595	70,017	85,089	.449	1.493
0.66	82° 36'	59° 30'	51° 28'	63,631	68,972	83,819	.436	1.515
0.65	81° 6'	58° 30'	50° 38'	62,667	67,927	82,549	.423	1.538
0.64	79° 36'	57° 31'	49° 48'	61,702	66,882	81,279	.410	1.562
0.63	78° 6'	56° 32'	48° 58'	60,738	65,837	80,009	.397	1.587
0.62	76° 38'	55° 34'	48° 9'	59,774	64,792	78,739	.384	1.613
0.61	75° 10'	54° 36'	47° 19'	58,810	63,747	77,469	.372	1.639
0.60	73° 44'	53° 38'	46° 30'	57,846	62,702	76,199	.360	1.667
0.59	72° 18'	52° 40'	45° 40'	56,881	61,657	74,929	.348	1.695
0.58	70° 54'	51° 42'	44° 51'	55,918	60,612	73,659	.336	1.724
0.57	69° 30'	50° 45'	44° 2'	54,954	59,567	72,389	.325	1.754
0.56	68° 6'	49° 48'	43° 14'	53,990	58,522	71,119	.314	1.786
0.55	66° 44'	49° 51'	42° 25'	53,026	57,477	69,849	.303	1.818
0.54	65° 22'	47° 54'	41° 37'	52,061	56,432	68,579	.292	1.852
0.53	64° 0'	46° 58'	40° 48'	51,097	55,387	67,309	.281	1.887
0.52	62° 40'	46° 2'	40° 0'	50,133	54,342	66,039	.270	1.923
0.51	61° 20'	45° 6'	39° 12'	49,169	53,297	64,769	.260	1.961
0.50	60° 0'	44° 10'	38° 24'	48,205	52,252	63,499	.250	2.000
0.48	57° 22'	42° 18'	36° 49'	46,277	50,162	60,959	.230	2.083
0.46	54° 47'	40° 28'	35° 15'	44,349	48,072	58,419	.212	2.174
0.45	53° 30'	39° 33'	34° 27'	43,385	47,026	57,149	.203	2.222
0.44	52° 13'	38° 38'	33° 40'	42,420	45,981	55,879	.194	2.273
0.42	49° 40'	36° 49'	32° 5'	40,492	43,891	53,389	.176	2.381
0.40	47° 9'	35° 0'	30° 31'	38,564	41,801	50,799	.160	2.500
0.38	44° 40'	33° 12'	28° 57'	36,636	39,711	48,259	.144	2.632
0.36	42° 12'	31° 24'	27° 24'	34,708	37,621	45,719	.130	2.778
0.35	40° 58'	30° 30'	26° 38'	33,744	36,576	44,449	.123	2.857
0.34	39° 44'	29° 37'	25° 51'	32,779	35,531	43,179	.116	2.911
0.32	37° 20'	27° 51'	24° 18'	30,851	33,441	40,639	.102	3.125
0.30	34° 56'	26° 4'	22° 46'	28,923	31,351	38,099	.090	3.333
0.28	32° 32'	24° 18'	21° 14'	26,995	29,261	35,559	.078	3.571
0.26	30° 10'	22° 33'	19° 42'	25,067	27,171	33,019	.068	3.846
0.25	28° 58'	21° 40'	18° 56'	24,103	26,126	31,749	.063	4.000
0.24	27° 46'	20° 48'	18° 10'	23,138	25,081	30,479	.058	4.167
0.22	25° 26'	19° 2'	16° 38'	21,210	22,991	27,940	.048	4.545
0.20	23° 4'	17° 18'	15° 7'	19,282	20,901	25,400	.040	5.000
0.18	20° 44'	15° 34'	13° 36'	17,354	18,811	22,860	.032	5.555
0.16	18° 24'	13° 50'	12° 5'	15,426	16,721	20,320	.026	6.250
0.15	17° 14'	12° 58'	11° 19'	14,462	15,676	19,050	.023	6.667
0.14	16° 5'	12° 6'	10° 34'	13,498	14,630	17,780	.020	7.143
0.12	13° 47'	10° 22'	9° 4'	11,570	12,540	15,240	.014	8.333
0.10	11° 29'	8° 38'	7° 34'	9,641	10,450	12,700	.010	10.000
0.08	9° 11'	6° 54'	6° 3'	7,713	8,360	10,160	.006	12.500
0.06	6° 53'	5° 10'	4° 32'	5,785	6,270	7,620	.004	16.667
0.05	5° 44'	4° 18'	3° 46'	4,821	5,225	6,350	.003	20.000

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104	2 inches	17	2 10 0	22	36	67	90	112
105	1½ inch	23	2 10 0					
106	1 inch	25	2 0 0	70	112	210	280	350
107	1 inch	32	2 10 0					
108	1 inch	45	2 10 0	100	160	300	400	500
109	¾ inch	65	4 0 0	125	200	375	500	625
110	⅔ inch	95	5 0 0	150	240	450	600	750
111	⅕ inch	75	3 10 0	200	320	600	800	1000
112	⅕ inch	120	4 10 0	250	400	750	1000	1250
113	⅕ inch	130	5 0 0	400	640	1200	1600	2000
114	⅕ imm.	180	5 5 0	500	800	1500	2000	2500
115	⅕ imm.	180	8 0 0	750	1200	2250	3000	3750
116	⅕ imm.	180	10 0 0	1000	1600	3000	4000	5000
117	⅕ inch	160	20 0 0	2000	3200	6000	8000	10,000

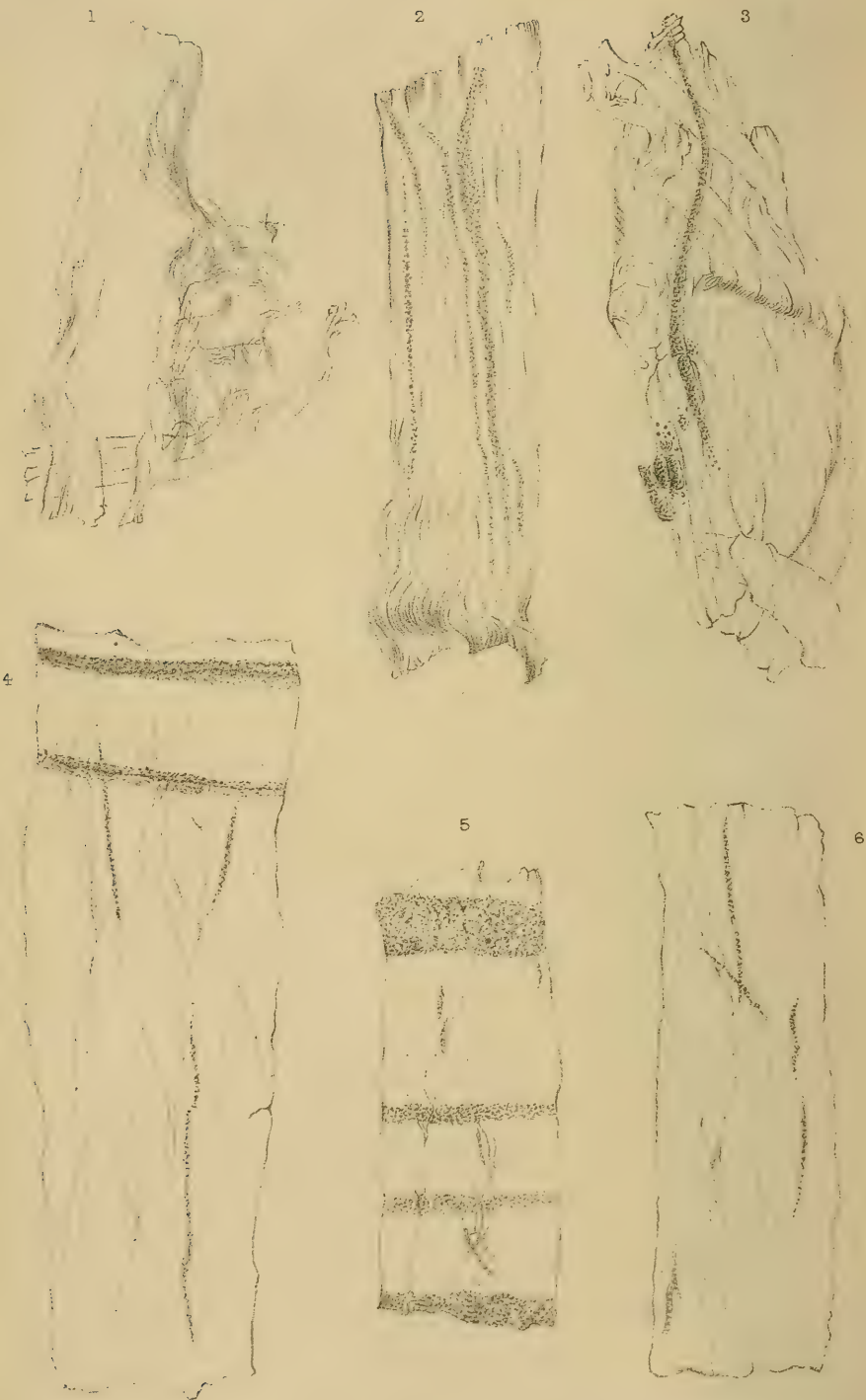
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154	1 inch	80	1 5 0	170	220	415
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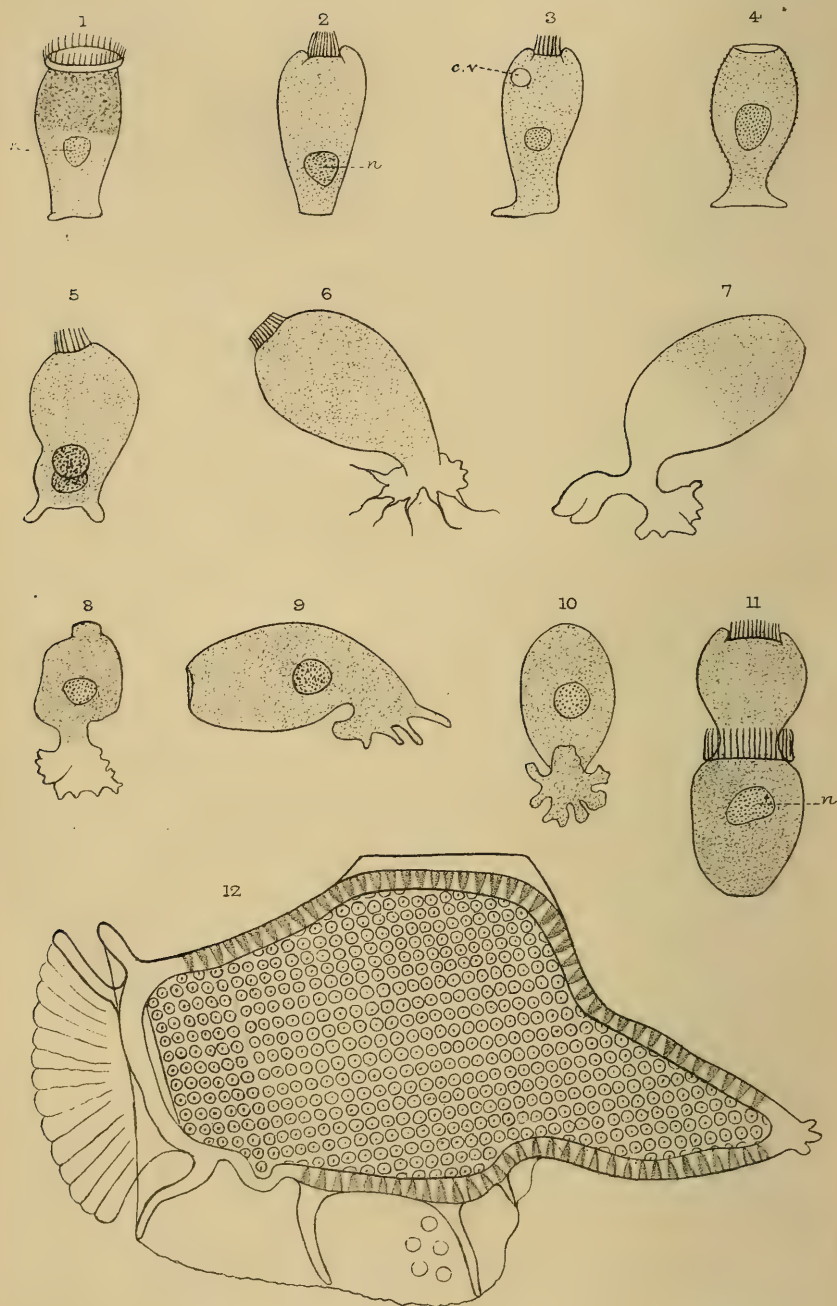
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OF THE

ROYAL MICROSCOPICAL SOCIETY.

AUGUST 1887.

TRANSACTIONS OF THE SOCIETY.

IX.—*On the Different Tissues found in the Muscle of a Mummy.*

By R. L. MADDUX, M.D., Hon. F.R.M.S.

(Read 11th May, 1887.)

PLATE X.

To some it may be a matter of surprise, to others a question of utility, to have gone back amongst the dead of remote ages in search of a subject for microscopical examination, whilst on every side we are surrounded by living organisms whose structure is unknown. Yet let me venture to hope the result which I now have the honour to bring to the notice of the Fellows may justify the selection. Whatever may be the opinion entertained of this record of the examination, it must be admitted there is one point upon which the dead doth not speak, nor can the living offer more than silence, and that is whether a thousand or two thousand or more cycles have slipped away "with the years beyond the flood" since this muscle-structure possessed life. The time, however, has certainly been beyond a period in which we could fairly hope for the preservation and identification of any part of the minute organic tissues of either the muscular, vascular, or nervous systems.

It was to satisfy myself upon this point, but more especially as regards the preservation of the striated character of voluntary muscle, that the examination was undertaken. Very possibly others have previously made like researches, but the limited means at my disposal have not enabled me to discover any record of a similar examination. Should such be within the knowledge of some of the Fellows whose opportunities have been greater, it is still hoped this paper may extend our knowledge and dispose of some of the difficulties that attend such studies.

No doubt, in the present instance, much is due to the very careful way in which the preservation of the dead was carried out, for in two

EXPLANATION OF PLATE X.

- Fig. 1. Fibrillæ in mummy muscle $\times 200$.
 - " 2. Remains of blood-vessels (?) in mummy muscle $\times 200$.
 - " 3. Broken blood-vessel in mummy muscle $\times 200$.
 - " 4. Delicate nerve-fibres in mummy muscle $\times 200$.
 - " 5. Ditto.
 - " 6. Ditto.
- (All the figures have been reduced from 400 to 200 diam.)

other examinations all trace of minute structure was lost, the tissues being so impregnated with the asphalt, pitch, or resinous gums and other materials used in the process of embalming, as to be useless under any of the methods of investigation that were adopted with success in this case.

About nineteen years ago there was handed to me a portion of a human mummy, the arm (I believe of a female), obtained before 1853 from one of the many Egyptian tombs, by a friend since deceased. A small piece was cut from one of the muscles—if I remember correctly, the triceps—which had been exposed by the removal of the various investing bands of linen, and carefully wrapped in note-paper, and put aside for a more convenient time, and thus came to be forgotten until a few weeks since. The little piece that was removed was about $1\frac{1}{4}$ in. long, pliable, and looking closely like a small tuft from an old cocoa-nut fibre mat or a dirty bit of spent tan.

A very cursory examination proved so attractive, that it was determined to no longer delay a more strict investigation. The question was how best to proceed, and in order to vary the methods the following reagents were used. The parts taken from the bit of muscle were cut from each end, also from the middle, and placed to soak in them for a fortnight:—

1. Glycerin 4 dr., glacial acetic acid 4 m.
2. Glycerin 4 dr., liquor potassæ (B. Ph.) 1 dr.
3. Glycerin 4 dr., sweet spirit of nitre 2 dr.
4. Glycerin 4 dr., saturated solution of boracic acid 1 dr.
5. Glycerin 4 dr., glac. acet. acid 4 m., and chloride zinc 6 gr.
6. Distilled water 4 dr., glac. acet. acid 2 m.
7. Saturated solution of salicylic acid.
8. Distilled water 3 parts, hydrochloric acid 1 part.
9. Distilled water 6 parts, nitric acid 1 part.
10. Distilled water 2 parts, rectified spirit 1 part.
11. Distilled water 16 parts, chloral hydrate 1 part.
12. Equal parts of this solution and rectified spirit.
13. Turpentine.
14. Chloroform.

15. A portion of the muscle was boiled for ten seconds in a little distilled water.

16. A similar piece was boiled for the same time in equal parts of distilled water and rectified spirit. These portions were allowed afterwards to soak in these fluids for three or four days. It may here be remarked that the boiling shrank the tissue very much, and rendered it tough and elastic, possibly from the gums used in the embalming process.

As several of these reagents offered no peculiar advantage, only those which proved most useful will be now mentioned.

No. 1 enabled me to separate the fibres into smaller bundles by means of needles and the dissecting Microscope, but did not allow of any perfect separation into fibrillæ.

No. 5 permitted the dissection to be carried further and to bring into view numerous fibrillæ, also a blood-vessel filled with rather coarse granular contents.

Nos. 8 and 9 allowed the compression of the fibres until they pre-

sented only a finely granular appearance, but in this could be detected numerous fine fibres of different refractive power from the rest of the substance. These delicate fibres with high powers could be traced into different planes forming a plexus.

No. 16 permitted the examination of similar fine fibres to be carried perhaps a little further.

The objects, when prepared for the purpose of examination, were temporarily mounted either in a saturated solution of potassic acetate and distilled water equal parts, or in distilled water with such portions of the reagent that remained adherent to the small portion of muscle that was selected.

In order to avoid assuming the correctness of my own interpretation of the appearances presented under the Microscope, every endeavour was made to photograph the structures, but where the delicate and the densely coloured portions were in the same field of view, it was found impossible to distinctly render the former, such as the fibrillæ and nerves, the same becoming through over-exposure too feeble to print with fair definition in the positive, before the exposure had been long enough to impress the image of the denser parts, consequently I was driven to the use of the pencil and camera lucida to portray these structures—structures which it was not in any way anticipated would be thus far found intact. The figures of plate X. have been drawn to a scale larger than the photomicrographs, or really than necessary, but this was done expressly that the parts might be more readily distinguished. A lower magnification was tried, but the result was less satisfactory, and it was more difficult to use.

The macroscopical appearances have already been alluded to. In the microscopical examination the first thing that was noticed in a large number of the portions that had been teased out by the needles was a coarse, granular striation, crossing at irregular intervals at right angles to the course of the fibres. This is shown in fig. 5 and in photograph No. 1. I have no satisfactory theory to offer to account for this peculiarity, which was evidently not directly due to the pressure of the bandages, as in many of the bits of muscle they were far too near each other for that idea, but it struck me as the process of embalming was often carried out or begun very shortly after death, that in this case it might have been before the *rigor mortis* had passed away, and that the albuminoid fluid substance of the muscle had been coagulated, and as it seems impressed or imprisoned under the rigor of the muscular structures.

The next notable appearance was the preservation of the muscular fibres, but unfortunately minus their own striation. In some of the prepared specimens, the muscular structure presented a beautiful wavy character which did not admit of perfect straightening, and in some cases where one of the needles used, a thin pointed flat one, had been pressed somewhat heavily on the fibres, these had been broken up into finer bundles and finally pressed out or broken up into their respective fibrillæ, whilst here and there in other specimens fibrillæ as fine lines could be seen stretching across from fibre to fibre of the teased-out muscle. The former only have been represented in fig. 1. An unsuccessful attempt has been made to photograph both conditions. Photographs 2 and 3.

In numerous specimens a peculiar appearance of aërolated lines was noticed, which generally followed the course of the fibres, but sometimes ran rather obliquely across them. These looked very much like long interspaces, varying slightly here and there in width, that had been filled with some fluid that had coagulated and imprisoned minute air-spaces. One specimen was photographed for part of its course which was more than double that depicted in the printed photograph No. 4. The slight swellings are visible in the part represented. Several of these aërolated spaces are also shown in the figs., especially fig. 2. They remain a puzzle to me, but they led me to search most carefully for some perfect minute vessels, and after spending much time over the slides I was rewarded by finding a small vessel charged with rather coarse granular contents lying between the fibres. It had been broken across in its course, and separated only a very short distance from it were likewise three small broken portions of the same vessel. The attempt to reproduce this by photography, photograph 5, has not been as successful as desired on account of the non-actinic colour of the structure, hence it has been figured more highly magnified, fig. 3. Whether the contents were blood constituents greatly altered by the process of embalming or perhaps by the injection of some preservative liquid is doubtful, but the appearance is sufficiently characteristic of its vascular nature. The use of immersion lenses disclosed nothing more satisfactory, as regards the granular contents, though some of the few separated granules seemed to have a kind of halo round them. Thus far the examinations proved very interesting. Two apparently different vessels or empty tubes were dissociated from the fibres by the needles, but it appears to me they cannot safely be said to belong to either the lymphatic or vascular systems, for some parts of the muscle had been invaded by a mildew growth. Curiously this mycelium had spread *across* the fibres and not in the direction of their length. These two tubes appeared too large to be the basic mycelium tubes connected with the smaller branches of what were regarded as due to a growth of *Penicillium* from the few conidia found lying amongst them. These vessels or tubes were photographed in order to furnish an idea of their appearance, and on the nature of which I do not venture to offer any definite opinion. Photograph 6.

During the examination of many of the prepared specimens, where the fibrous structures had been purposely compressed, the eye continually glimpsed minute fibres of a different refractive power from the other parts, running for a short distance in the substance of the muscle, and then lost to view. This led me to endeavour to prepare some of the specimens so that their course could be more completely followed. By very careful focusing the fibres could now be traced through different levels, although the plexus brought into view is figured in each drawing as if it occupied only one plane. Figs. 4, 5 and 6. Without much hesitation, I think these fine fibres must be regarded as nerve-fibres. They were not seen in any of the specimens as long as the muscle structure retained its fibrous appearance, but when it was softened, compressed, and had assumed a more or less finely granular character, then these delicate nerve-fibres were brought into view. The mode of preparation that gave perhaps the best results was when boiled for ten

seconds with water and rectified spirit, or when water with nitric acid had been used as the reagent. Every effort to photograph these structures failed, the brown non-actinic colour and density of the substance prevented the necessary differentiation, though perfectly visible under the Microscope with careful focusing. These fine fibres appeared in part as continuous bright lines, in part as grey lines, according to the position of the mirror. Unfortunately the stock of osmic acid was exhausted or it would have been used to try and render these fine fibres yet more apparent. Under none of the reagents used did the muscle structure afford any perfect evidence of the peculiar striation belonging to voluntary muscle, but some of the fibrillæ appeared to be made up of minute dots united in line, though how far this may have been inherent to the structure, or how far due to the general coagulation that was apparent in the highly compressed and softened muscle, is doubtful; but this much may be noticed, that the purposely softened muscle in which the nerve-fibrils were most visible, presented no trace of perfect muscular fibrillæ.

Although, correctly speaking, not belonging to the microscopical side of this interesting subject, this paper would be much more incomplete without some notice of the acknowledged methods of embalming, for the examination of a specimen kindly sent to me by Prof. Stewart of the Royal College of Surgeons proved absolutely useless, the flesh apparently having been placed in a bath of melted bitumen, or something of the kind, by which all structure was lost, and also in another specimen, for which I was indebted to the kindness of Mr. Shore, manager of the Hartley Institution, Southampton, which was somewhat brittle, and though treated with the same reagents, furnished no satisfactory results; still it is feared, even with this assistance, we shall find no sufficient clue to the method of preservation used in the present case. To enter into all the details would far exceed the limits of this paper, and the subject must, therefore, be but cursorily dealt with.

Whatever the origin of embalming, the process was perfected in Egypt. Besides the description given by Herodotus of the different methods, some instructions have been found in the Rhind papyrus. All the great cemeteries had their establishments for the reception and embalming of the dead, and it is stated that in those belonging to the necropolis of Memphis, there were always from 500 to 800 corpses passing through the different processes. Herodotus explains that the brains were removed through the nostrils, the intestines by an incision in the left side of the abdomen, which was then cleaned with palm wine, and afterwards filled with myrrh, cassia, &c., and the body steeped for many days in a solution of natron, an impure soda-salt found in the Natron Lake of the Libyan Desert in Upper Egypt. After the steeping, the body was handed to the swathers and bandaged with gummed cloths, and made ready for the coffin. The cost of the different methods is given as varying from 243*l.* to 96*l.*—the less costly method. This consisted in filling the abdomen with cedar-tree pitch or pine pitch, the body being steeped in the natron bath, the contents of the abdomen being allowed to escape or eviscerated by other means. The corpse of the poor was placed in natron for many days (70), after rinsing the abdomen with "*syrmæa*." Asphalt was said to be used with the more costly methods, and wax but

rarely. In some cases, it is stated, the body was immersed in melted bitumen. A species of tanning was also employed. Sometimes the viscera, after cleansing, were replaced, but more frequently embalmed separately, and placed in a vase near the mummy, the emptied abdomen being filled with chips of cedar sawdust, and a little natron. The cast linen of the household was usually kept for the bandages. The swathing was begun at the toes and fingers, then carried over the whole body in numberless bands; from 700 to 1200 yards of bandages, or strips three or four inches wide, it is written, have been unrolled from a single mummy. The mummies of Memphis are described as black and brittle, and those of the time of the Hebrews as yellow and flexible, the flesh even yielding to pressure, and the limbs capable of altered position without breaking. This flexibility is supposed to have resulted from the use of very costly injections of chemical solutions into the vessels, as the natron process largely destroyed the structures. The under bandages were dipped in spirit and applied wet. When Syrian turpentine came into use as in Thebes, the mummies were blacker than those of Memphis, both the bandages and body being greatly hardened. In later periods some of the bodies had an ashen grey appearance, others that were treated with bitumen were dark coloured and heavy. The methods described by Herodotus, Diodorus Siculus, and others, have been more or less confirmed by MM. Jomard, Royer, and Larrey, in their '*Description de l'Égypte*.' The evisceration by incision is said to have been adopted for the rich. The mummies in which the cavities were filled with aromatic resinous bodies are somewhat olive coloured, with distinct features, the teeth, hair, and eyebrows remaining mostly perfect. Those in which the body had been filled with bitumen, are somewhat reddish, with a hard skin, and are not very alterable on exposure to the atmosphere, the features remaining moderately perfect. Those that have been salted do not differ much from the last, but the hair has generally dropped off, and the features are not so perfect. When the impure bitumen or pisasphalt was used internally, it was also supposed to have been used very hot, so as to impregnate all the tissues. The bodies that were only salted and dried remain less perfect, the features being destroyed, the hair removed, while the skin is hard and parchmenty. The Egyptian modes of embalming were copied by the Jews, Greeks, and Romans.*

The more perfect Jewish method was probably the one employed in preserving the mummy that furnished the muscle that has been the subject of this paper, though this must be accepted as a matter of speculation.

The appearances under the Microscope of living and recently dead muscle are not strictly alike, the latter has more opacity besides other differences. The muscle fluid, myosin, has been found to coagulate at 45° C., and the same temperature sets up rigor mortis, and at 75° C. the albuminoids become coagulated. In spite of the diligent physiological and microscopical researches that have been made in studying the complex character of living muscle, we are yet confronted by many

* For the rules and methods of embalming I am indebted to the pages of the *Encyclopædia Britannica*, 9th ed., the *Penny Cyclopædia*, and *Kitto's Cyclopædia of Biblical Literature*.

difficulties, and it is doubtful if the last words have yet been said in connection with its attributes and structure; hence we can hardly expect that the dead tissues of remote ages, no matter by whatever method preserved, should be found to closely correspond with the living or recently dead similar structures. We have lost the striation and its doubly refracting power, the sarcolemma and the long pointed nuclei, and how far the chemical substances, myosin, glycogen, inosit, creatin, &c., remain intact in the mummy muscle, is very doubtful. The withdrawal of moisture with the use of materials to delay tissue change we must expect will prevent any very perfect restoration as a whole of this highly delicate complex tissue. With the separation of the bundles of fibres into smaller ones, and these again into finer ones, all of which are held together by connective tissue, until we end at the fibrillæ, we must, it appears, for the present be content in our comparison of the recent muscular structure and the remote dead. To have gained this much with the addition of vessels and nerves, was worth the inquiry.

NOTE.—Since the foregoing was read, one of the Members of the Council, Mr. Julien Deby, has drawn my attention to a paper by Czermak,* published in 1852, containing the result of his examination of two Egyptian mummies, and having most kindly placed the article at my service, I am enabled to add this very brief summary of the interesting details of the microscopical examination. The mummies were those of an adult female and of a lad about 15 years of age, and dating from a period of 2000 years since; the former being in a very marked state of preservation, having been most carefully prepared and wrapped with about 4000 yards of bandages, though not a person of an exalted station. The boy was much damaged, hence the examination chiefly refers to the former. Czermak, after giving a general description of the condition of the different parts of the bodies, and alluding to the method of embalming and the excellent preservation of the female mummy, which he attributes especially to the natron used in the process, passes to the microscopical details, of which he gives thirteen very carefully drawn figures. On referring to these it will be noticed that Czermak was very fortunate, as he found the striation in one of the voluntary muscles—the sphincter of the eyelid—by making use of turpentine as the examining medium; but this medium failed entirely in my hands, and also upon making a further trial of the same. He does not appear to have obtained the separation into fibrillæ, as his figure is that of a bundle of fibrils. To accomplish this separation it seemed to me to be necessary to swell the tissues very gradually. There is another most interesting point in Czermak's paper, he having been able to recognise the axis cylinder in the fibres composing the median nerve of the arm. It will need no apology to offer a very brief notice of the microscopical details, as his paper may not be of easy access to many of the Fellows.

The following refers to the figures as given in the plate at the end of the paper:—

1. The cells with nuclei of a section of the nail of the ring finger of the female mummy.
2. A longitudinal section near the root of the nail.

* SB. K. Akad. Wiss. (Math.-Naturw. Cl.), ix. (1852).

3. Hair of the head of the female, showing the sheath.
4. A cross section of the hair near the root.
5. The cells of the inner sheath.
6. Henle's and Huxley's layers.
7. A transverse section of the muscle of the thumb, *flexor pollicis longus*, treated with water.
8. The cartilage cells of the ear of the small mummy.
9. Section of the cartilage of the patella, with the cells *in situ*.
10. Cartilage cells from the rib of the female mummy.
11. Nerve-fibres of the median nerve in which besides the nerve-substance the axis-cylinder can be also seen.
12. A few muscular fibres from the sphincter of the eyelid as seen in turpentine, showing the striation and other appearances.
13. A section of the fatty layer in the great toe of the adult mummy, with the fat-cells in position.

Czermak speaks of one of the former Presidents of the Society, Prof. Quekett, having shown him a figure of the hair of a mummy in one of the Nos. of the 'Microscopical Journal.' Unfortunately I am unable to specialise the number.

It will thus be seen that by the aid of the Microscope it has been possible to touch the fringe, and gather up a few threads of "the frayed border of the royal robe" worn long centuries since, but carefully folded up and laid aside as a legacy to the wardrobe of time.

X.—Remarks on the Foraminifera, with especial reference to their Variability of Form, illustrated by the Cristellarians.—PART II.

By Prof. T. RUPERT JONES, F.R.S., F.G.S.,
and C. DAVIES SHERBORN, F.G.S.

(Read 8th June, 1887.)

PART I. of this paper, in the 'Monthly Microscopical Journal' for February 1876, contained a synoptical Table of the published varieties of *Cristellaria*, from the time of Linné to 1840; and an attempt was made to reduce these numerous figured forms to their proper zoological positions, by referring them to the few best-pronounced types of *Cristellaria*. In the two plates illustrating the above-mentioned paper, there were figured a series of Foraminifera, all belonging to the Nodosarinæ; and they exemplified the gradual passage from the straight, many-chambered shell of this kind of Foraminifera to the most perfect spiral form. At the same time it was shown that the cylindrical and compressed shells of varying thickness were merely varieties of the same form. It has been thought advisable to continue the Table as a guide to future workers in this group of Microzoa; and in this paper the Cristellarians are now further zoologically tabulated to the end of 1860.

It having been found impossible, for want of space, to include those other groups of Nodosarinæ which are closely connected with *Cristellaria*, we have omitted hundreds of references to the many varieties of *Margulinæ*, *Vaginulinæ*, and other sub-groups, which cannot, if regarded biologically, be separated from the *Cristellariæ*. The most striking series of these omitted forms will be found in a paper by Neugeboren, published in the Verh. Mitth. Siebenburg. Ver. Nat., ii. 1851, where a series of forty-five partially-coiled Nodosarinæ are figured, most of which have been elevated by him to the rank of "species." Others are to be found in a paper by M. Cornuel in the Mém. Soc. Géol. France, sér. 2, iii. 1848; in Reuss' "Westphälischen Kreide," SB. K. Akad. Wiss. Wien, xl. 1860, &c.

In drawing up the Table, five forms have been selected as the chief types around which to group the *Cristellariæ*; these are, *C. calcar* (Linné), representing the keeled and rowelled forms, and of which all spiral *Cristellariæ* are specifically varieties; and, as convenient sub-varieties of this, *C. cultrata* (De Montf.), representing the keeled forms; *C. rotulata* Lam., the keelless forms; *C. italica* (Deffr.), the triangular-elongate forms; and *C. crepidula* (Fichtel and Moll), including all compressed-elongate forms. It must, however, be understood that these five varieties are not themselves to be considered as really distinct, but are used merely as available heads of divisions into which the *Cristellariæ* may be sorted. Some few subordinate names are kept, with the alliances indicated.

In the Table, the middle column gives the names bestowed by different authors upon the varieties which they have described as "species." Those names which we consider to be of sufficient value to be kept for classificatory purposes have been printed in larger type; while, on the other hand, those which are unmistakably the same as our recognised types are printed in smaller type, to indicate the advisability of allowing their pseudo-specific name to drop. There is certainly

a fictitious, though to some extent a practical, value in these pseudo-specific names, when the student is collecting and arranging Foraminifera, if he is desirous of distinguishing minute differences by nomenclatorial terms; but he should not be led to exaggerate the zoological value of such varietal forms and conditions. Further, were naturalists to use only such terms as might be approved of by exact biology, the discoveries and observations made by earlier authors would perhaps be too often forgotten or laid aside. Indeed, it is necessary to retain for classificatory purposes many names given by these earlier workers, and very desirable that observers should refer to these older works thoroughly, when seeking for comparisons and new names. Amongst the several Bibliographies of Foraminifera known to us, that appended to H. B. Brady's 'Report on the Foraminifera of the Challenger Expedition' is by far the best; it has carefully brought the literature of the subject into notice, and is very useful for the above-mentioned purpose of enabling the student to find what has already been done in this line of research.

Since 1860, the period at which our present Table closes, there have been published a very great number of papers on the Foraminifera; the labours of Reuss, Terquem, Karrer, and others having brought to our notice hundreds of forms, amongst which the *Nodosarinæ* predominate. Of these papers we do not propose now to treat; but it will be useful to refer to a work, by von Schlicht,* who, in a series of thirty-eight large plates, illustrating the Foraminiferal fauna of one deposit (corresponding, according to Hermann Credner,† to our Hempstead Beds of the Isle of Wight), devotes eight and a half quarto plates, containing two hundred and thirteen figures, to the *Cristellarix* alone. To the delineation of other members of the *Nodosarinæ* (*Lagena* to *Marginulina*) he gives ten and a half plates, with two hundred and sixteen figures. Von Schlicht only grouped his specimens in "genera"; but von Reuss, in the SB. K. Akad. Wiss. Wien, lxii. 1870, carefully described most of the forms, making many new "species." The most cursory examination of these plates will show the extremely close connection existing between all the forms; and, having in hand the illustrations of so fine a series from one deposit, and therefore of so large a group of forms most probably living continuously in one area, and under one set of conditions, we are enabled to see in a striking manner how greatly one form can and does pass into manifold varieties, and how difficult it is to recognise the limitation of species, and say where they begin and where they end.‡

It only remains to again point out the completeness of the chain which has for its links the sub-groups *Lagena*, *Glandulina*, *Nodosaria*, *Dentalina*, *Marginulina*, *Vaginulina*, and *Cristellaria* (including *Robulina*); and again to draw attention to the infinite number of varieties, whose only claim to "specific" position consists in the varying curvature of the shell; other modifications, such as surface-marking, form and position of orifice, variable flattening of the shell, &c., being common to each of the several sub-groups above-mentioned.

* 'Die Foraminiferen des Septarienthones von Pietzpuhl,' 4to, Berlin, 1870.

† 'Elemente der Geologie,' 8vo, Leipzig, 1883.

‡ The recognition of these difficulties evidently led Dr. Goës to compile the valuable lists in his paper on "The Reticularian Rhizopoda of the Caribbean Sea," K. Svenska Vetensk.-Ak. Handl., xix. 1882.

p. 96	f. 10-13 ..	..	..	cultrata (De M.) ..	..	C. cultrata, with broad keel, umbonate and limbate.
p. 98	f. 14, 15 ..	..	..	similis d'O. ..	..	" with broad keel.
"	f. 16, 17 ..	..	..	ornata d'O. ..	..	C. costata, subvar. Symmetrical and keeled; with partial ornament only.
p. 99	f. 18-20 ..	..	..	calcar* (L.) ..	..	C. calcar. The septal lines less vortical than in Fichtel and Moll's figures.
p. 100	f. 21, 22 ..	..	..	echinata † d'O. ..	..	C. calcar. Subvar., ornamented with granules and some longitudinal marks.
p. 101	f. 23, 24 ..	..	..	clypeiformis d'O. ..	..	C. cultrata, limbate, umbonate, and with rather narrow chambers.
p. 102	f. 25, 26 ..	..	..	inornata d'O. ..	..	C. rotulata, thick and few-chambered.
p. 103	f. 27, 28 ..	..	..	simplex d'O. ..	..	" rather thick.
"	t. 5, f. 1, 2 ..	..	..	austriaca d'O. ..	..	"
p. 104	f. 3, 4 ..	..	..	intermedia d'O. ..	..	" with subvortical chambers.
"	f. 5, 6 ..	..	..	imperatoria ‡ d'O. ..	..	C. vortex, keeled and umbonate.
1846. R. A. PHILIPPI. "Verzeich. Magdeburg. Tert."				Paleontographica, vol. i.		
p. 81, t. 10A, f. 21 ..	..	..	..	Nonionina Magdeburgica Ph. ..	..	Cristellaria cultrata (De M.); umbonate and limbate.
1847. MICHELOTTI. "Terr. mioc. Italie septentr."				Nat. Ver. Hollandsche Maatschap. Wetensch. Haarlem, 2 ser., iii.		
p. 15, t. 1, f. 1 ..	..	..	..	Robulina depressa M. (1841) ..	..	Cristellaria.
p. 14	f. 2 ..	..	..	antiqua M. (1841) ..	..	C. rotulata.
"	f. 3 ..	..	..	Cunningi M. (1841) ..	..	C. cultrata.
p. 13	f. 5 and 5 ₁ ..	..	..	Cristellaria cassis (F. & M.) ..	..	C. cassis (F. & M.); subdiabelline.
"	(not figured) ..	..	..	Robulina Hauseri M. ..	..	C. cultrata, with numerous curved chambers.
"	" ..	..	..	Cristellaria Partschii M. ..	..	" subcarinate.
1848. CORNUEL. Mém. Soc. Géol. France, ser. ii, vol. iii, part 1 (Cretaceous).						
p. 253, t. 2, f. 1-4 ..	..	..	..	Planularia reticulata C. ..	..	} Planularian Vaginulines. Planularian Marginulines; fig. 11 is near Cristellaria sub-arcuatula.
"	f. 5-8 ..	..	..	costata C. ..	..
p. 254,	f. 9, 10 ..	..	..	Cristellaria lituola C. ..	..
"	f. 11-13 ..	..	..	excentrica C. ..	..
p. 255	f. 14-16 ..	..	..	voluta C. ..	..

* *R. aculeata*, Ann. Sc. Nat., vii. p. 289, No. 14.

† *R. calcar*, Ann. Sc. Nat., vii. p. 123, No. 12, var. 6, F. & M.

‡ *R. vortex*, Ann. Sc. Nat., vii. p. 288, No. 4.

1851. A. E. REUSS. "Tert. Oberschlesien." Zeitsch. Deutsch. Geol. Ges., iii. pp. 149-184.
p. 153, t. 8, f. 4 Cristellaria auriformis Rss. Elongate, compressed, subvar. of *C. rotulata*, with a few granules at umbilicus, and therein chiefly differing from *C. juglevi* Rss.
" f. 5 *C. inops* Rss. Subvar. of *C. italica*, thick and suborbicular.
p. 154 " f. 6 *Robulina angulata* Rss. *C. rotulata*, angular at the septa.
1851. A. E. REUSS. "Foram. Kreid. Lemberg." Haid. Nat. Abh., iv.
p. 32, t. ii. (iii.) f. 7 *Cristellaria angusta* Rss. *Cristellaria crepidula*, narrow.
" f. 8 " truncata Rss. *C. crepidula*, ill-grown, with large umbo.
p. 33 " f. 9 " multiseptata Rss. " with largish coil.
" f. 10 " Spachholtzi Rss. *Cristellaria rotulata*, compressed.
" f. 11 " obvelata Rss. *C. italica*, swollen.
p. 34 " f. 12 *Robulina trachyomphala* Rss. *C. rotulata*, umbonate.
1852. T. R. JONES. Quart. Journ. Geol. Soc., viii.
p. 267, t. 16, f. 12 *Cristellaria platypleura* Jones *Cristellaria cultrata*, with strong limbation.
" " " " *Wetherelli* Jones *C. italica*.
1853. J. BROWN. "Artesian Well, Colchester." Annals Mag. N. H., ser. ii. vol. xii.
p. 241, pl. ix. f. 6 *Cristellaria rotula* *C. rotulata*.
1854. J. G. BORNEMANN. "Liasformation Göttingen." 8vo, Berlin.
p. 39, t. iv. f. 27, a, b *Cristellaria protracta* Born. Much produced Marginuline *Cristellaria*.
p. 40 " f. 28, a, b, c " Listi Born. } Produced and curved Marginuline *Cristellaria*. Fig. 30, slightly keeled.
" f. 29, a-c " lituoides Born. }
" f. 30, a-c " spirulina Born. }
" f. 31, a, b " major Born. } Broad Marginuline *Cristellaria*.
p. 41 " f. 32, 33, 34, a-c " varians Born. } Broad *C. crepidula*; fig. 32 being nearest to the type, and possessing a keel.
" f. 35, a, b " deformis Born. } Marginuline *Cristellaria*.
" f. 36, a, b " granulata Born. }
p. 42 " f. 37, a, b " minuta Born. } Broad marginuline *Cristellaria*.
" f. 38, a, b " convoluta Born. }
" f. 39 " (section).
p. 43 " f. 40, 41, a, b *Robulina Göttingensis* Born. *Cristellaria rotulata*.
" f. 42, a, b " nautiloides Born. " cultrata, with weak keel.

SYNOPTICAL TABLE—continued.

p. 327, t. 13, f. 16, 17	..	..	Cristellaria convergens B.	..	..	C. rotulata, arrested and produced.
p. 328 " f. 18	..	..	elliptica B.	..	..	"
" f. 19, 20	..	..	excisa B.	..	..	C. cultrata, subcarinate.
p. 337, t. 14, f. 1-3	..	..	Robulina deformis Rss.	..	..	"
p. 338 " f. 4, 5	..	..	" navis B.	..	..	"
p. 332 " f. 6, 7	..	..	" angustimargo Rss.	..	..	"
" f. 8-10	..	..	" Beyrichi B.	..	..	"
p. 337 " f. 11	..	..	" depauperata Rss.	..	..	C. rotulata.
p. 336 " f. 12	..	..	" incompta Rss.?	..	..	C. cultrata.
p. 334, t. 15, f. 1	..	..	" radiata B.	..	..	"
p. 335 " f. 2, 3	..	..	" inornata d'Orb.	..	..	C. rotulata.
" f. 4-6	..	..	" limbata B.	..	..	C. cultrata.
p. 336 " f. 7	..	..	" limbata (?) B.	..	..	"
" f. 8	..	..	" sp. ..	..	..	C. italica?
" f. 9, 10	..	..	" trigonostoma Rss.	..	..	C. cultrata, subcarinate.
p. 333 " f. 11	..	..	" declivis B.	..	..	semicarinate (half cultrata, half rotulata).
p. 334 " f. 12, 13	..	..	" integra B.	..	..	"
" f. 14-16	..	..	" integra (?) B.	..	..	"
p. 338 " f. 17	..	..	" compressa B.	..	..	semicarinate and produced.
1855. O. G. Cosra. "Foram. Foss. d. Marina blu d. Vaticano." Mem. R. Acc. Sci. Napoli, ii.	..	..	Cristellaria Volpicellii C.	..	..	Cristellaria italica, keeled.
p. 120, t. 1, f. 4	..	..	" contracta C.	..	..	" irregular growth.
p. 121 " f. 5	..	..	" obesa C.	..	..	" subarcuatula, varieties.
" f. 7	..	..	" pulchella C.	..	..	"
" f. 8	..	..	" Marginulina triangularis d'Orb.	..	..	rotulata, limbate.
p. 119 " f. 9	..	..	" Robulina Austriaca d'Orb.	..	..	calcar var., few-chambered, limbate and longi-
p. 122 " f. 10	..	..	" Vaticana C.	..	..	tudinally costulate.
" f. 17	..	..	"	..	..	"
1855. O. G. Cosra. "Foram. foss. d. Marne tert. di Messina." Mem. R. Acc. Sci. Napoli, ii.	..	..		..	..
Frondicularia (unilateralis).						
p. 372, t. 3, f. 5	..	..	Frondicularia typica C.	..	..	Planularia rostrata d'Orb.
" " f. 9	..	..	" angustata C.	..	..	cymba d'Orb.
" " f. 7	..	..	" lanceolata C.	..	..	auris Deff.

	f. 16	"	"	similis C.	"	"	"	narrow subvar.
	f. 17	"	"	subulcata C.	"	"	"	rostrata d'O.
	f. 19	"	"	silicula C.	"	"	"	subvar., with straight ventral edge and costulae.
p. 373, t. 2, f. 26		"	"	longiuscula C.	"	"	"	Planularia auris, narrow and apiculate.
"	t. 3, f. 14	"	"	subangulata C.	"	"	"	"
"	f. 12	"	"	ovata C.	"	"	"	"
"	t. 2, f. 25	"	"	interrupta C.	"	"	"	"
"	t. 3, f. 20	"	"	"	"	"	"	"
1855. A. E. REUSS. "Kreid. Mecklenburg."				Zeitsch. D. G. Ges. vii. pp. 261-292.				
p. 269, t. 8, f. 16, t. 9, f. 1, 2		"	"	Cristellaria decorata Rss.	"	"	"	Marginuline <i>Cristellaria</i> , bead-limbate, near Marginulina Wetherellii Jones.
p. 271, t. 9, f. 3		"	"	prominula Rss.	"	"	"	C. cultrata, limbate.
p. 272 " f. 4		"	"	Robulina signata Rss.	"	"	"	" and umbonate (umbo impressed with marks).
"	f. 5	"	"	megapolitana Rss.	"	"	"	C. cultrata, limbate.
1855. A. E. REUSS. "Tertiärsch. nördl. u. mittl. Deutschlands."				Sitzungsber. Akad. Wien, xviii.				
p. 232, t. 2, f. 31, t. 3, f. 32, 33		"	"	Cristellaria gladius (Philippi)	"	"	"	Figs. 31, 32, 33, narrow <i>C. crepidulae</i> or Marginuline <i>Cristellaria</i> .
p. 233, t. 3, f. 34-36		"	"	arcuata (Phil. and Karsten)	"	"	"	C. crepidula, varieties, more or less C. subarcuatula, limbate.
p. 235 " f. 37		"	"	arguta Reuss	"	"	"	C. crepidula, limbate, with large coil.
"	f. 38	"	"	auricula (von M.)	"	"	"	Pl. auris Defr. var.
p. 236 " f. 39		"	"	mirabilis Rss.	"	"	"	C. italica Defr., swollen.
"	f. 40	"	"	Nauckana Rss.	"	"	"	C. crepidula, limbate.
p. 237 " f. 41		"	"	polita Rss.	"	"	"	C. italica Defr., rather compressed; or young C. rotulata.
"	f. 42	"	"	Landgrebeana Rss.	"	"	"	C. rotulata, umbilicate and limbate.
"	f. 43	"	"	subcostata von Münster	"	"	"	Depressed variety of C. vortex, more or less limbate.
p. 238, t. 4, f. 44, 45		"	"	Osnabrugensis von M.	"	"	"	
1856. O. G. COSTA. "Atti dell' Accad. Pontaniana,"				vol. vii. fasc. 2, 1856.				
p. 195, pl. x. f. 12		"	"	Robulina calcar (Linn.)	"	"	"	[There is no figure corresponding to this in Costa's plates.]
p. 190 " f. 17		"	"	Cristellaria rotulata d'Orb.	"	"	"	Elongate marginuline <i>C. rotulata</i> .
p. 191, pl. xiv. f. 1		"	"	" gibbosa Costa	"	"	"	C. rotulata.
"	f. 2	"	"	Robulina subangulosa Costa	"	"	"	C. rotulata.
p. 191, pl. xvi. f. 24		"	"	Cristellaria gibbosa var.	"	"	"	C. italica.
p. 192, pl. xvii. f. 1 and 3		"	"	bicornis Costa	"	"	"	C. bicornis; Fig. 1 is described as <i>C. coarctata</i> in the text.

SYNOPTICAL TABLE—continued.

p. 193, pl. xvii. f. 2..	..	..	Cristellaria paucispina Costa	..	..	C. calcar var.
— f. 18	..	..	" (monstrous).	..	..
p. 196, pl. xix. f. 1 ..	..	..	Robulina elypeiformis var. festonata Costa.	..	..	C. cultrata var.
p. 193	..	..	Cristellaria magna Costa	..	..	C. cultrata.
p. 229	..	..	Robulina inequalis Costa	..	..	C. cultrata.
p. 198	..	..	" elegantissima Costa	..	..	C. italica, ribbed var.
p. 230	..	..	" cancellata Costa	..	..	C. cultrata.
p. 229	..	..	" inornata d'Orb.	..	..	C. rotulata.
— " f. 7 ..	..	..	" semistriata Costa	..	..	C. rotulata, ribbed var.
— pl. xx. f. 14 ..	..	..	" lobata Costa	..	..	An angular <i>C. rotulata</i> .
— " f. 17 ..	..	..	" ambigua Costa	..	..	? [A thin <i>Cristellaria</i> of doubtful specific value and affinity.]
— pl. xxvii. f. 23	..	..	Cristellaria compressa Costa	..	..	<i>C. compressa</i> d'Orb., sub-var. of <i>C. crepidula</i> (F. & M.).
1856. J. L. NEUGBOREN. "Stichostegier von Ober-Lapugy," Denkschr. k. Ak. Wiss. Wien., xii.	..	..	..	..	..
p. 103, pl. v. f. 12 ..	..	..	Marginulina vagina Neug. ..	..	..	Marginuline <i>Cristellaria</i> .
1857. J. G. EGGER. "Foram. Miocän. Ortenburg," Neues Jahrbuch, 1857.	..	..	..	..	..
p. 296, pl. xiv. f. 28-30 ..	..	..	Cristellaria arcuata d'Orb.	..	..	Long <i>Cristellaria italica</i> .
p. 296, pl. xiv. f. 31-33 ..	..	..	Cristellaria incerta Egger	..	..	Cylindrical three-chambered Marginuline <i>Cristellaria</i> .
" " f. 34, 35 ..	..	..	" simplex d'Orb.	..	..	Thick <i>C. crepidula</i> .
p. 297, pl. xv. f. 12, 13 ..	..	..	Robulina compressa Egger	..	..	Few-chambered, swollen, umbilicate <i>C. rotulata</i> .
" " f. 14-16 ..	..	..	" inornata d'Orb.	..	..	{14, 15. Large-chambered <i>C. rotulata</i> . 16. The same, keeled = <i>C. cultrata</i> .
1858. W. v. d. MARCK. "Diluvial-Kieses vom Hamm," Verh. Nat. Ver. Preuss. Rheinl., xv.	..	..	..	..	..	<i>Cristellaria</i> near <i>C. vortex</i> .
p. 53, pl. i. f. 4 ..	..	..	Cristellaria flabellinoides v. d. M.	..	..
1858. O. TERQUEM. "Mém. Foram. Lias"—Première Partie. Mém. Ac. Imp. Metz, t. xxxix.	..	..	..	..	..
p. 619, pl. iii. f. 14 ..	..	..	Cristellaria matutina (d'Orb.) antiquata (d'Orb.)	..	..	{ Marginuline <i>C. rotulata</i> , much produced.
p. 620	..	..	" prima d'Orb.	..	..	Thin <i>C. cultrata</i> .
p. 621	..	..	" vetusta d'Orb.	..	..	Marginuline <i>C. rotulata</i> , much produced.
p. 622	..	..	" Terquemi d'Orb.	..	..	A Planularian <i>C. crepidula</i> , partly keeled.
" " f. 18 ..	..	..	" rustica d'Orb.	..	..	<i>C. rotulata</i> .
p. 623	..	..	" ornata Terq.	..	..	A <i>Planularia</i> .
" pl. iv. f. 1 ..	..	..	" speciosa Terq.	..	..	A <i>Marginulina</i> .
p. 624	..	..	" geniculata Terq.	..	..	Deformed <i>Planularia</i> .
p. 625	..	..	"	..	..

XI.—On new species of *Scyphidia* and *Dinophysis*.

By J. G. GRENFELL, F.G.S.

(Read 8th June, 1887.)

PLATE XI.

LAST September I came across an exceedingly interesting new species of *Scyphidia* living parasitically on the tails of some sticklebacks in Dorsetshire. From its habit I propose to call it *Scyphidia amœbæa*. I have not yet found it on the sticklebacks near Bristol. The points of special interest are two: first, the mode of attachment, and secondly the process of reproduction, which has hitherto been unknown in any species of this genus. Sometimes the animal is simply attached by the posterior end of the body in the ordinary way, without there being anything to draw special attention to this part; as in plate XI. fig. 1, 2; or again the base may be widened out, as in fig. 4. But in the great majority of cases, the animal is attached by means of pseudopodia, as in figs. 5–10. These may take the form of a single lobe or of two simple lobes, and so on up to several large highly complicated processes. I found it hard to draw these accurately from the living animal, because the stickleback's tail interfered with the light; but by killing with salicylic acid and staining I obtained a number of good specimens free. On the living animal I sometimes found that the lobes of the pseudopodia ended in threads, but these are not visible in preserved specimens.

I do not know of a parallel case among the Peritricha; but among the Holotricha *Stentor Roeselii* sometimes has pseudopodic projections round the base, according to Simroth, but much smaller and less complicated ones than in the present case.

The integument of this species is highly elastic, as in the rest of the genus, and the animal consequently assumes a variety of forms, as may be seen in the figures. On the whole, however, the body is conical, increasing in width from the base upwards. The surface of the integument sometimes seemed highly granular in living specimens.

The body is generally divided into two distinct portions; the upper half is very coarsely granular; it contains the contractile vesicle in its upper portion; the lower half of the body is nearly always very much clearer; in its upper part lies the very large granular nucleus which is always a very conspicuous object, is broadly egg-shaped, or sub-triangular, and occasionally I have seen this divided into two parts. The peristome is well developed.

I met with one live specimen in the act of dividing by transverse fission. This is shown in fig. 14. A well-marked constriction had been formed, and the new ciliary wreath was in active motion all round. I did not trace the process further than this, but I think there can be no

EXPLANATION OF PLATE XI.

- Fig. 1–6.—*Scyphidia amœbæa* from the living animal.
 „ 7–10, from preserved specimens.
 „ 11.—*Scyphidia amœbæa* dividing; from the living animal.
 „ 12.—*Dinophysis semicarinata*.

doubt as to what was going on. This is the first record of the mode of reproduction in the genus.

I was not aware that any theoretical importance attached to this observation till on my return home, I obtained Prof. Bütschli's very ingenious and interesting paper on the relationship of the Vorticellina to the other Ciliata. In this paper Prof. Bütschli limits the Vorticellina to Stein's three families of Vorticellina, Ophrydina, and Urceolarina. He points out that in the Vorticellina the adoral wreath of cilia forms a right-handed spiral, while in *Stentor* and other Ciliata the spiral is left-handed. He also recalls the fact that in the Vorticellina division is longitudinal instead of transverse, and shows how both these peculiarities can be explained by supposing the Vorticellina to be derived from some such form as *Licnophora*. By a change in the orientation of the Vorticellid body the adoral wreath becomes the dorsal surface, the point of attachment to the stalk is the ventral surface, and their division is once more transverse.

But Saville Kent has shown that *Ophrydium Eichornii* frequently divides by longitudinal fission, and here is *Scyphidia*, a genus placed very close to *Vorticella*, also dividing transversely.

If this proves to be the normal method of division in the genus, and if Prof. Bütschli's theory is to stand, it would seem that *Scyphidia* must be relegated elsewhere, to near *Spirochona* probably. I do not think this a satisfactory solution of the difficulty.

But what is to be done with *Ophrydium*? This genus divides both ways, which if hereditary would imply a longitudinal division, as well as a transverse one, in its ancestors among the Ciliata of the *Lienophora* type. Is not that impossible? or is the direction of fission determined in some cases by the shape of the animal? As the other Ciliata are in the habit of dividing longitudinally after conjugation, and have the power of reproducing any part of their body, is it impossible to suppose that the same cause which originally made the elongated Ciliata divide transversely may also act in making the elongated Vorticellina divide transversely to their length? If this were possible, *Ophrydium* would be a connecting link between *Scyphidia* and the Vorticellina in respect to reproduction. The length of this species is about 0.00275 in. for a good sized specimen, and the width about half the length. This or a closely allied species is also found on the loach.

From a surface gathering in Port Royal Harbour, Jamaica, I obtained the species of *Dinophysis* shown in fig. 15. It was common and the only species present. Of the species figured in Stein's great work it most resembles *D. Homunculus*; but the position of the projecting foot, which instead of being on the axis of the body lies in a line with the ventral edge of the rest of the body, together with the keel-like ridge on the back, distinguish it at once from Stein's species.

Saville Kent has described, but not figured, a species, *D. caudata*, which in some respects is very like this one. The chief points of difference are as follows:—

1. In *D. caudata* the body is said to be "inflated," and is compared in shape with the body of *D. norvegica* and *D. acuminata*, which are distinctly rounded in outline. The new species is not rounded at all.

2. *D. caudata* is described as having a smooth ridge or keel running along the dorsal surface of the broad part of the body, apparently along its whole length. The new species has this ridge confined to the distal half of the broad part.

3. No reference is made to the small knobs at the end of the foot, one or more of which are always present in the new species.

In various other points the language is hardly that which would naturally be used in describing the Port Royal species, but the above are, I think, sufficient.

Description of the new species. The body expands posteriorly, and terminates in a large foot-like prominence, the ventral edge of which is in a line with the ventral edge of the rest of the body. This terminates in one, two, or three, small knobs, or prominences. A smooth keel-like ridge runs along the posterior half of the dorsal edge of the wide part of the body. The funnel at the head is very large, larger, I think, than in any other species. It is very nearly equal to the whole width of the body. Its surface is wrinkled, not finely striated as in Saville Kent's species. The collar, round the neck, posterior to this, is very delicate and difficult to see; but its dorsal extremity is strengthened by a thick and long projection of the cuirass. This projection is also characteristic of the species. The ventral plates are three or four in number, the fourth one being a small posterior one, as figured. The first of these seems to be attached to the right valve of the cuirass, and the second to the left valve. This latter plate is frequently more or less veined with a network of approximately circular meshes. The cuirass is extremely thick and is pierced with many holes, which at the level of the surface are large, and form a complete network; at a lower level they terminate almost in a point.

From its half keel I propose to call it *D. semicarinata*. Length 0.0036 in.; breadth of body 0.0016 in.; breadth, including ventral plates, 0.0022 in.

SUMMARY
OF CURRENT RESEARCHES RELATING TO
ZOOLOGY AND BOTANY
(*principally Invertebrata and Cryptogamia*),
MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Continuity of Germinal Protoplasm.‡—Dr. W. Richter discusses the various factors in organic evolution with special reference to Weismann's conclusions. The greater portion of his paper covers very familiar ground, but the degree of misunderstanding between Virchow and Weismann is lucidly and carefully explained. In the latter part of his paper the author takes as a special case the variations which he has observed in the connective tissue of human subjects. A list of these is given. The same variations occur independently of local inheritance, in mechanical response to functional demands. The local modification cannot be said to be directly inherited, but is the result of an associated quality of connective tissue expressing itself through a definite law of growth. The relation of Weismann's conclusions to psychology is finally discussed. Their essential consistency with the main propositions of the natural selection theory is maintained throughout.

Development of the Carnivora.§—Dr. A. Fleischmann has carried out some interesting investigations upon the development of the Carnivora, on which he reports as follows:—

Material was hard to obtain, in spite of the fact that cats and dogs are to be found as pets in every family. From one hundred to one hundred and fifty cats were examined weekly during the rutting periods in February and June. Later it was found possible to obtain materials from animals kept in confinement. Besides this, useful material was obtained through sportsmen from foxes and wild cats.

A series of stages of the domestic cat was obtained by the successive extirpation of the horns of the uterus. The preservative fluid was picrosulphuric acid, to which one-tenth per cent. of chromic acid had been added.

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Biol. Centralbl., vi. (1887) pp. 40-50, 67-80, 97-108.

§ Ibid., vii. (1887) pp. 9-12. Cf. Amer. Natural., xxi. (1887) pp. 334-6.

The author has not yet been able, in spite of great care and patience, to find the ova of the cat and dog in process of segmentation in the oviducts. The youngest ovum which he found was a somewhat oval blastosphere, upon which the germinal area was already very distinct. This was invested by a very distinct Rauber's layer of cells.

The youngest blastosphere of the cat is nearly spherical, and twelve days after the first copulation still presents the form of an oblong sphere. Through rapid growth at the poles, it soon, however, becomes citron-shaped; the germinal area then forms a convex elevation on the middle third of the blastosphere.

While the blastosphere of the dog retains the two-pointed, citron-shaped form, that of the cat retains that form for only a very short time, and becomes barrel-shaped, in that the points of the blastosphere are pressed inward by mutual pressure in the successive sections of the uterine cornua, so that the ends of the growing blastospheres are only feebly conical. The flattened extremities of the blastosphere are not undergrown by mesoderm, and therefore no vessels are developed in that portion of them. At the outer margins of the flattened ends of the barrel-shaped ovum, there is a delicate reticulum formed of elevations of the ectoderm, which has apparently arisen by pressure of the ends of the hollow ovum upon the folds of the uterine mucous membrane.

Around the entire germinal area and at the opposite side of the blastosphere, on the twelfth day, there are already formed small projections and elevations of the ectoderm, which serve to attach the ovum to its nidus. Before the allantois has reached any considerable dimensions, the subzonal membrane has thrust out villi in all directions, and into these grows the connective tissue supporting the outer vascular layer of the allantoic sac.

The primitive groove is formed in the germinal area at right angles to the long axis of the blastosphere; the same direction is assumed by the medullary groove. At about the sixteenth day the entire germinal area changes the direction of its axis to one parallel with that of the axis of the ovum, a condition which the embryo maintains until birth.

In the primitive streak the mesoderm is formed exclusively from the outer walls of the primitive groove; in many sections one sees the mesoderm proliferating outward from the sides of the primitive streak between the two primary embryonic layers, and numerous cleavage figures indicate rapid growth in this region. The entoderm is always distinctly marked off from the mesoderm, and the author could not obtain clear proof of the entoblastic origin of the mesoderm. Even at the anterior end of the medullary groove the mesoderm is always sharply marked off from the other layers; a heaping up of the mesoderm on the entoderm as described by E. van Beneden is not apparent.

The mesoderm is characterized in well-preserved germinal areas, from eleven to thirteen days old, as a solid mass of cells, which is composed of several layers of cells under the germinal area, but consisting, outside of the latter, of but a single layer of cells.

The coelom first appears as clefts in the mesoblast outside of the germinal area, and is pushed in under the latter at a later period.

A chordal canal is always developed, and opens at a number of points into the cavity of the umbilical vesicle or yolk-sac; an opening of this canal into the anterior end of the primitive streak was not discovered. Only in an advanced embryo, with ten somites, could a slight ectodermal depression be discovered at the anterior end of the primitive streak, but this was closed below by a mass of cells.

In front of the medullary groove lies a completely closed mass of mesoblast; the interamniotic pore, described by E. van Beneden and Julin, was not observed in young germinal areas.

The anterior amniotic fold in the cat, dog, fox, and mole is not covered by mesoderm, but consists wholly of ectoderm and entoderm. It follows from this that there is found a proamnion not only in Rodents, Bats, and Marsupials, but also in Carnivora and Insectivora, from which it may be concluded that it is a structure common to the Mammalia. The significance attached to it by Van Beneden the author cannot share.

The Wolfian duct does not arise as a solid cord of cells, but, as the author observed in the duck, as a diverticulum of the coelom; that the ectoderm takes part in the formation of the Wolfian duct was not established.

As respects the formation of the maternal placenta, the author fully confirms the statements of Bischoff, that the villi of the chorion grow into the uterine glands, destroying the latter.

Embryology of Monotremata and Marsupialia.*—Mr. W. H. Caldwell has published an abstract of the first part of his paper on the development of Monotremata and Marsupialia. In very young ova of the former there is a fine membrane between the single row of follicular cells and the substance of the ovum; this vitelline membrane at first increases in thickness with the growth of the ovum, and numerous fine protoplasmic processes pass through it and connect the protoplasm of the follicular cells with that of the ovum; these serve for a time to conduct food granules. This "yolk-forming period" is succeeded by an "absorption of fluid period," during which the ovum absorbs large quantities of fluid, and increases in size; the third period is that of the formation of the chorion. All these periods are gone through while the egg is still in the follicle. In the passage of the egg along the Fallopian tube the vitelline membrane again increases in thickness, and the chorion absorbs fluid and becomes the albumen layer; outside this now appears the shell or shell-membrane, which is tough and parchment-like, without calcic salts in *Echidna*, but apparently with them in *Ornithorhynchus*. The deposition of the shell has not yet been observed to be due to the activity of any special glands, but the author says the shell-membrane does not increase at the expense of the chorion or albumen layer. In Marsupials the yolk-forming period is not marked off from the absorption of fluid period; in an ovum of *Phascolarctos* there was a thin transparent shell-membrane.

The ova are telolecithal, and go through a partial segmentation; though the ova of Placentalia segment completely, the resulting blastodermic vesicle is identical with that of Monotremes and Marsupials. A primitive streak region is formed, in Monotremes, in front of the posterior lip to the blastopore, and long before the epiblast has enclosed the yolk. In Marsupials the epiblastic growth encloses the hypoblast at a very early stage, except over a narrow slit in front of the posterior lip of the blastopore; the primitive streak is not conspicuous at an early age, because of the large size of the cells. Balfour's objection to the comparison of the blastopore of the rabbit with that of the frog is explained by the presence of a posterior lip to the blastopore in Marsupials; the author postulates the existence of a similar structure in the rabbit, and regards its blastopore as corresponding to the whole area marked out by the growing epiblast and the posterior lip of the blastopore before the closing of the primitive streak region.

* Proc. Roy. Soc. Lond., xlii. (1887) pp. 177-80.

Wall of Yolk-sac, and Parablast of the Lizard.*—Dr. H. Strahl finds that the yolk sac of reptiles presents many resemblances to that of birds; the yolk-sac is at no period a vesicle equally thick in all its parts and composed of two simple layers; the mode of growth of the endoblast appears to be peculiar, for it does not widen out as a special epithelial membrane, but its cells are found around the yolk.

In agreement with Kupffer, the term parablastic is applied to the cells which lie beneath the endoblast, after the development of the three germinal layers; their parablastic cells may be seen even during the cleavage period, when they are formed by a transverse division of the germ; and the defined masses of yolk-spheres may be seen in all further stages; they lie partly between the cords of vessels or endoblast-cells, which form the lower thick wall of the yolk-sac, and partly at its free edge; it has not yet been definitely shown that they contain cell-nuclei. In the later stages of development free cells may be distinctly seen within the yolk-sac; these are sometimes very numerous; the cells are small, and have a distinct nucleus; they are irregularly scattered in the yolk-sac, and look as though they were lymphoid cells. It is possible that some of the parablast-cells take a part in the formation of the endoblast, but this point cannot be yet definitely settled; there is no reason to suppose that the cells arise or multiply by free-cell formation. The author discusses in detail the supposition of Kollmann that the germinal ridge (marginal ridge, Kollmann) is the seat of origin of the blood; and he comes to the conclusion that there is no reason for accepting this hypothesis, or that a zone separated off from the mesoblast gives rise to the blood-vessels. What Kölliker has shown to be true of Birds and Mammals seems to hold also for Reptiles.

Maturation and Fertilization of Amphibian Ova.†—Dr. O. Schultze has been led by his studies on the ova of Amphibians to some general results; he finds, as do those who have investigated the ova of other classes of animals, that the germinal vesicle shares the fate of all the parts that do not form the directive corpuscles, and passes into the substance of the egg-cell; greater weight must henceforward be laid on the fact that there is a complete intermixture of the female nuclear substance and the cell substance before fertilization. The nuclear substance which is collected around the germinal vesicle as it commences its retrograde metamorphosis is sharply separated, in some cases even by a temporary membranous layer, from admixture with the substances of the egg. After a time this separation ceases, and the two parts soon unite. A part of the chromatic substance passes to the surface of the egg, and then by a double mitotic division gives rise to polar bodies; in the unripe egg of the Amphibia the germinal vesicle occupies a central position so long as its fluid substances are equally grouped in the direction of all the rays; yolk-gemmules, which are quite distinct, soon collect, and increase in size; the egg then becomes telolecithal. Objection is taken to van Beneden's epithet of "pseudo" as applied to the karyokinesis which obtains in the egg of *Ascaris megalocephala*; and the author concludes with enumerating the proved cases of the presence of polar globules in vertebrates.

Structure of Ovum of Dipnoi.‡—Mr. F. E. Beddard has a further contribution to our knowledge of the structure of the ovum in *Protopterus*, and some notes on the ovary of *Ceratodus*; in the latter form the multicellular

* Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 282-307 (1 pl.).

† Ibid., pp. 177-226 (3 pls.).

‡ Proc. Zool. Soc. Lond., 1886 (1887) pp. 505-26 (3 pls.).

or plasmodial ova, which are sufficiently common in the former, are much more rare than the ordinary unicellular ova. Mr. Beddard points out that the fact of there being two kinds of ova with a different mode of development is not new to the Vertebrata, as the "egg-nests" of Elasmobranchs suffice to show; and these egg-nests are common among Vertebrates. In all these, however, both kinds of eggs have morphologically the value of a single cell. The important facts to be borne in mind in comparing the egg-nests of Elasmobranchs with the ova of Dipnoi appear to be the early formation of the complicated follicular layers in the latter and the early commencement of yolk-secretion; the temporary fusion of the primitive ova in the Elasmobranchii, and the degeneration of some of them becomes permanent in the Dipnoi, the ovum being the equivalent of a whole nest. The apparent absence of any protoplasm in the yolk-mass of these remarkable structures in the Dipnoi renders it extremely unlikely that the structure develops into an embryo. The formation of ova as described by Prof. Huxley in *Lacinularia* appears to be clearly analogous to the fusion of a number of germinal cells in *Protopterus* and *Ceratodus*.

Vesicle of Balbiani.*—M. L. F. Henneguy has been studying sections of ovaries of young guinea-pigs and rats, fixed immediately after death by Flemming's mixture of chromic, acetic, and osmic acids; in the young ovules he always found a slightly refractive body with well-marked contours, placed near the germinal vesicle. This—the vesicle of Balbiani—is found in young primordial ova, but is not found in such as are more advanced; its coloration is uniform, its substance chromatophilous, and not arranged in a plexus as in the nuclei. The author enumerates the various forms in which he has succeeded in finding it, and then passes to the very interesting observation that his studies on the testicle of the rat has shown him that the so-called accessory nucleus which has been recently studied by Nussbaum and Platner, ought to be regarded as comparable to the vesicle of Balbiani in ova.

The only reagent which, at present, is found to be useful in fixing this vesicle is that of Flemming.

Atavism.†—Mr. J. Bland Sutton tries to show that, using the classification of Prof. Gegenbaur, all examples of atavism are palæogenetic, and that none are neogenetic, or not found as a germ in the embryo; the prostate is selected as affording a remarkable instance of atavism, and it is regarded by Mr. Sutton as a suppressed uterus, the fibro-muscular tissue representing the matricial walls, the follicles corresponding to the reticular glands, and the reticulus itself being identical with the cervix uteri and the immediate adjacent portion of the vagina. It seems to be clear that the prostatic concretions and egg-shells agree structurally and chemically and are produced by homologous organs, so that man has in his prostate an unimpeachable witness of an ancestry with the feathered tribes low down among the oviparous reptiles.

Dealing with secondary sexual characters, the author urges that the known facts seem to point to the conclusion that the epiblast is chiefly derived from the male element, while the female pronucleus is chiefly responsible for the hypo- and greater portion of the mesoblast; if this be true, the transmission of characters peculiar to the male is not so obscure as many have supposed.

* Sep. Rep. Bull. Soc. Philomath. Paris, 1887, 4 pp.

† Proc. Zool. Soc. Lond., 1886 (1887) pp. 551-8.

*β. Histology.**

Karyokinesis.†—Prof. W. Waldeyer gives a useful historical résumé, with interpolated criticisms, of recent researches on cell-division, with accompanying diagrams and bibliography.

Cup-shaped Cells.‡—M. L. Ranvier discusses the vacuoles of cup-shaped cells, the movements of the vacuoles and the intimate phenomena of the secretion of mucus, taking as his object of investigation the cells found in the epithelial covering of the membrane which invests the retro-lingual lymphatic sac of the edible or the grass-frog. In answer to the question, Is the vacuolar movement a vital one? M. Ranvier finds that it ceases on the death of the cells. After staining, it is possible to see that the vacuoles are situated in the mass of protoplasm which occupies the base of the cell, or in the protoplasmic processes which are given off from it, and they may, therefore, be found in any region of the cup-shaped cell from its base to its orifice. When the cells are examined in the living state it may be noticed that some of the vacuoles which they contain disappear more or less rapidly and before reaching the surface of the mucous membrane. It is probable that, breaking within the cell, they pour out, along the lines of protoplasmic substance, the liquid which they contain, and that this liquid, bathing the masses of mucigen, carries away part of it. Thus charged with mucin it arrives at the surface converted into mucus.

Giant Cells of Tubercle.§—Herr A. Obrzut concludes, from his observations, that a giant tubercular cell does not represent a histological unit, but in reality a conglomeration of endo- or epithelial cells hypertrophied by the influence of the parasites of the tuberculosis, and that it is, as usually observed, in process of undergoing retrogressive modifications.

Alteration of the Red Blood-corpuscles.||—In normal blood Sig. A. Mosso finds corpuscles which become altered with the greatest ease, while others are more resistant. It is impossible to examine microscopically the blood of most animals without destroying or profoundly altering a certain number of corpuscles. Mere contact with glass suffices to quite decolorize, alter their shape, and bring the nucleus into view. In the red corpuscle can be distinguished a skeleton or network, which is brought out by maceration and digestion. By digesting the blood of various animals, especially birds, in gastric juice, a red corpuscle is seen to be composed of an external envelope, of a granular fibrillar network, and of a nuclear sac. Within the nuclear sac are usually seen ten to twelve corpuscles, which stain more deeply than the nucleus. Between the external envelope and the nucleus may be distinguished, even in mammals, a median zone, which the author calls the cortical part. It is composed of two substances so intimately commingled that they form a homogeneous substance in the physiological condition, but which separate on alteration of the corpuscle, and then the one looks transparent and the other yellow from hæmoglobin. Sig. Mosso has seen crystals within the corpuscles of dog's blood, coagulated slowly or rendered incoagulable by the addition of pancreatine. These crystals are rhomboidal, with well-marked angles, and yellow in colour, and concentric in position. The diameter of the corpuscles being about 6 or 7 μ , the crystals measure 2.5 μ to 5 μ . The resemblance of these crystals to

* This section is limited to papers relating to Cells and Fibres.

† Arch. f. Anat. u. Physiol., 1887, pp. 1-30.

‡ Comptes Rendus, civ. (1887) pp. 819-22.

§ Arch. Slav. Biol., ii. (1886) pp. 402-25 (1 pl.).

|| Atti R. Accad. Lincei.—Rend., iii. (1887) pp. 252-7.

hæmoglobin shows that in the higher vertebrates there exists within the corpuscle a substance analogous to albuminoid bodies, and which is able to crystallize without the corpuscular form changing. The corpuscle is decolorized because the yellow substance separates from the other which is found in the cortical portion, and crystallizes without leaving a trace of the nucleus.

The normal form of the mammalian red corpuscle is not that of a biconcave disc, as is usually believed, but this appearance is produced by alteration of structure due to unsuitable conditions, mechanical violence, chemical reagents, and the like. In his experiments Sig. Mosso used very dilute solutions (sodium chloride 0.75 per cent., stained with methyl-violet 1 in 5000), alkaline eosin 1–2 per cent., NaCl 0.6 per cent., or methyl-green 1 per cent. Except blood-serum, all other fluids were found to alter more or less rapidly the red corpuscles, but contact with glass is stated to be extremely damaging. For example, if a drop of blood squeezed out of a pigeon's feather be treated with 2 per cent. eosin solution, and viewed without contact, the nucleus will be found unstained. But if the same drop be but lightly touched with a cover-glass, the corpuscles become altered, the nuclei become red and swollen, the cortical part more pallid, as if the hæmoglobin had disappeared. This great susceptibility of change Sig. Mosso considers to have been the cause of many errors, and these of such magnitude that it is necessary to repeat the whole course of the histology of the blood, for every ordinary method of examining blood destroys the cortical part of the corpuscle.

Sig. Mosso concludes by alluding to the differences in the resistance of red corpuscles. This resistance was measured roughly by means of 0.3 per cent. chloride of sodium solution, stained with methyl-violet 1:5000, and more accurately by successive strengths of the chloride solution (0.76–0.4 per cent.). These experiments are not yet fully completed, but it may be stated that the resistance for any given species is very variable, and that the corpuscles of birds are the most resistant.

Nuclei of Striated Muscle-fibre in *Necturus* (*Menobranchus*) *lateralis*.*—Mr. A. B. Macallum has obtained his best preparations of the nuclei of *Necturus lateral*is with gold chloride and formic acid; many of the isolated nuclei have on their surface furrows and striations; the former are probably due to the pressure exercised by the trabeculæ of the muscular reticulum; this last appears to the author to be the true contractile element, while the myosin shifts and accommodates itself. In some cases the reticulum was not on, but in the nucleus, and in these cases no chromatin or caryoplasma could be discovered. Mr. Macallum thinks with Carnoy and Melland that the muscle reticulum is simply the modified cytoplasma, the caryoplasma being derived from the latter. When the caryoplasma is modified as in some of the cells observed, the nuclei must be capable of movement, or of contraction and extension; the possession of a square-meshed reticulum implies extension and contraction in definite directions—the nucleus contracts with the muscle-fibre and extends with it again, yet not passively. Where nuclei have part of their surface completely free from furrows, we may suppose that part only of the nuclear body is surrounded by the muscle substance, a part of it lying between the latter and the sarcolemma.

Variations in Wool.†—Dr. F. H. Bowman gives an interesting account of variations observed in the structure of wool and other fibres. These indicate a constant tendency to a reversion to a more primitive type, besides illustrating the effects produced by the environment or by artificial selection

* Quart. Journ. Micr. Sci., xxvii. (1887) pp. 461–6 (1 pl.).

† Proc. Roy. Soc. Edin., 1887, pp. 657–72 (1 pl.).

Mollusca.

Shells of Cephalopoda.*—Herr E. Riefstahl, after pointing out the different relations held to their shells by Cephalopoda and Gastropoda, distinguishes the external shells of the Ammonites and recent Nautiloids from the internal shells of Belemnites and Squids. The great differences between shells depend on various modes of life; those of the Ammonites were almost more important as swimming organs than as defensive envelopes, for they were generally very thin and light, much lighter than those of the existing *Nautilus*; the shells of Belemnites were very strong, and gave the whole body great powers of resistance; they were enclosed by a thick skin rich in vessels, so that if they were injured they were rapidly healed. The *Sepiæ* have a light shell, which is, however, fairly strong. With regard to the formation of the septa, the author remarks that every septum arises from its predecessor, becomes separated from it by the increase in length of the intervening walls, and finally becomes a new strong septum; in consequence of this the hinder end of the body of the animal is always in contact with a septum, and does not need to secrete either air or chalk. There is good reason for ascribing to the Cephalopod-shell the independent mode of growth which has been detected in the Lamellibranchiata, and there is no reason for supposing that there is any secretion from the body of the animal.

Renal Organs of Prosobranchs.†—Herr G. Wolff gives a preliminary notice of his observations on the renal organs of German Prosobranch Mollusca, *Paludina vivipara*, *Bithynia tentaculata*, and *Valvata piscinalis* having been examined. He has been able to convince himself of the presence in all these of the internal orifice; the great reduction which this has suffered, greater even than in the Pulmonata, will explain Leydig's failure to find it in *Paludina*; it is least reduced in *Valvata*, where its duct has long and strong cilia. In *Paludina* the pericardial opening of the kidney is clearly in physiological connection with the opening of the kidney into the water-reservoir, for the muscular fibres which inclose the former are connected with the sphincter which embraces the latter. In *Bithynia* a glandular body which corresponds to the kidney of *Paludina* projects freely into the organ which may be regarded as the water-reservoir; it differs from *Paludina* in having two orifices, one upper and one lower, which lead to the exterior; the pericardial orifice is quite close to the former of these.

Glands in Foot of Tethys fimbriata.‡—Dr. J. H. List finds considerable differences in the presence of glands on the upper and lower sides of the foot of *Tethys fimbriata*; on the former there are unicellular mucous glands, unicellular glands with specially formed fat-like contents, which may possibly be phosphorescent organs, unicellular glands with special contents, some of which are often arranged in a lamellar manner, and similar glands which have coarsely granulated contents. Of the numerous glands there are two kinds; in one the form of the gland is flask-like, and these are bounded by a distinct membrane and contain two different masses, which are arranged as in the goblet-cells; there is a filar mass arranged in a meshwork, and an interfilar mass. The second form of unicellular mucous glands are quite like goblet-cells, even if they are not, as the author believes, epithelial elements. The glands, which may have a phosphorescent

* Naturforscher, xx. (1887) pp. 153-4, from Palæontographica, xxxii. (1886).

† Zool. Anzeig., x. (1887) p. 317.

‡ Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 308-26 (1 pl.).

function, are very largely developed, not only over the whole of the foot, but on other parts of the body; the contents are almost completely homogeneous and are of a fatty nature; it is to be noted that Grube has reported that *Tethys* is remarkable for its strong phosphorescence, and Panceri has remarked that the unicellular glands which serve as the luminous organ of Annelids have fatty contents.

In another form of gland lamellæ are found, some of which exhibit a concentric arrangement, but this may be due to the mode of hardening; the function of these glands is not quite clear, but it is certain that they are not mucous organs, though it is possible that they are byssus glands, the contents of which have been altered in the process of preparation. The glands with coarsely granular contents are pyriform in shape; their function is unknown.

On the lower side of the foot there are, in addition to the goblet-cells, a few small mucous glands, a comparatively small number of luminous organs, and a few scattered glands with granular contents. In addition to these there are specific organs which call to mind the multinuclear colour- and chalk-glands which Leydig has observed in the skin of many terrestrial Gastropoda. They have no surrounding membrane, and the cell-substance generally is a finely granulated mass; the nuclei are from two to seven in number in each cell, and colour well. They are very easily seen to be connected with connective-tissue cells; and the author believes that both they and the cells observed by Leydig are only further developed connective-substance cells, which remain in contact with the other cells of the same substance.

Anatomy of Patella.*—Dr. H. Wegmann contributes some notes on the structure of *Patella*, an animal often, but only partially studied. His bibliography only comes down to 1883, and the recent thorough research by Mr. R. J. Harvey Gibson has apparently not reached the author. The two systems which are especially discussed are the alimentary and vascular. An Infusorian parasite found on the gills is also described. As the ground covered by Dr. Wegmann's research is in part included in Gibson's monograph, the detailed anatomical results need hardly be summarized. The value of the investigation is increased by the comparison which is instituted throughout between *Patella* and *Haliotis*, as also by the excellent illustrations.

Molluscoida.

a. Tunicata.

Muscular System of Glossophorum sabulosum.†—M. L. Lahille describes the well-developed muscular system of this Tunicate, which he finds to be very simple and instructive. There are generally six pairs of lateral muscles, corresponding to the six buccal lobes; occasionally eight pairs—a sign of approximation to the Cionidæ which is paralleled by other characters in the organization of *Glossophorum*—are present. The author remarks, parenthetically, that he is about to demonstrate the homology of what he calls the stolon (post-abdomen of Milne-Edwards) with the vessels of the tunic of simple Ascidians, the proliferating stolon of the Salpidæ, and the endostylar bud of Pyrosomatidæ. Owing to the fact that the ova are always developed on the right side of the rectum, the lateral muscles of the right are shorter than those on the left side of the animal. M. Lahille does not agree with Traustedt that the deviation of the intestine produces

* Rec. Zool. Suisse, iv. (1887) pp. 269–303 (2 pls.).

† Soc. l'Hist. Nat. Toulouse, xx. (1886) pp. 107–116.

the muscular asymmetry, but is of opinion that the latter is the cause of the former. The other longitudinal muscles are the cloacal, of which there are three pairs, and the dorsal and the ventral, of which there are, respectively, one pair.

Of the transverse muscles, the buccal and cloacal present no remarkable characters; the branchials are found in the interior of each transverse sinus. The muscular bundle is always single in *Glossophorum*, which is interesting as being a primitive arrangement, known as yet to obtain only in the Salpidæ. The statement of Della Valle that there are no muscular fibres in the gills of Tunicates is traversed.

The mesodermic cells, which are elongated, and which give rise to the muscular fibres, have at points along their internal walls refractive thickenings of contractile substance; these are developed from the periphery of the cell towards its centre, and so have, in section, a prismatic form. The prisms increase in size till they leave between their faces only an extremely thin layer of protoplasm. The author agrees with Profs. Van Beneden and Julin in thinking that the muscles of adult Tunicates are mesenchymatous in origin and epithelioid in formation. The organogeny of the musculature of the Tunicates appears to be always of one type; but in the Salpidæ and Urodele larvæ the mesodermic cells do not elongate.

The symmetry of the Tunicata, as of the Nematodes and lower Vertebrates, appears to be eutetrapleural and interradian, but this homology is an adaptational and not a primitive one.

β. Polyzoa.

Morphology of Bryozoa.*—Herr A. A. Ostroumoff concludes his study of the morphology of the Bryozoa of the Gulf of Sebastopol. In regard to the metamorphosis of all the three types he notes:—(1) the formation of the basal surface at the expense of the cells of the posterior wall of the vent (ventouse); (2) the histolysis of the provisional larval organs, and of the alimentary canal if it be always present (*M. zostericola*, *Cyphonautes*); (3) the formation of an ectodermic rudiment of the alimentary canal, formed by the cells of the cap (calotte) which is invaginated (Ctenostomata?); (4) the formation on the surface of this rudiment of a mesodermic layer arising from the mesoderm cells of the larva.

Budding and regeneration are discussed at some length, and the author emphasizes, in conclusion, the following four most important results:—(1) the calcareous skeleton of Bryozoa is deposited between the cells of the ectoderm, which persists throughout the life of the cells as a single layer under the skeleton (in *Membranipora*), or as a double layer inclosing the skeleton (in *Lepralia*); (2) the body-cavity is mesenchymatous, without endothelial lining; (3) the vent forms, in Cheilostomata, the basal wall of the cell, and the stolon in *Vesicularia*; on its derivatives the new members of the colony are always budded off, except the opercula avicularia in *Cellularia* and *Escharella*; (4) the polypide is formed at the expense of the ectodermic rudiment and of the brown mass; the larva still exhibits in its early embryonic life a peculiar organ, known as the cap (calotte), and destined to form the above-mentioned rudiment.

Morphology of Ectoproctous Bryozoa.†—Dr. W. J. Vigelius, who in 1884 suggested that the skin of the adult was represented by the ectocyst, and that the ectodermal epithelial layer which gives rise to the tegumentary

* Arch. Slav. de Biol., ii. (1886) pp. 329-55 (5 pls.).

† Tijdsch. Nederl. Dierk. Vereen., i. (1887) pp. 77-92 (1 pl.).

skeleton is only found in very young buds and afterwards disappears, has been led to reconsider this. He now finds that in *Farella repens*, and another species, probably a *Membranipora*, there is on the surface of the tegumentary skeleton a thread indicating an epithelium formed of very large cells; these cells closely resemble the ectodermal cells of *Loxosoma* and *Pedicellina*; it is very difficult to detect this layer except in specimens which, when fresh, have been treated with nitrate of silver.

The author's researches on *Flustra* have shown him that the endocyst and endosarc are formed of the same non-epithelial tissue; this parenchymatous tissue appears to be a special form of connective tissue which is massive in the cords and reticular in the layers which line the cavity of the body. In *Bugula calathus* it often contains a number of spherical or ellipsoidal corpuscles, which are granular in appearance; they vary greatly in their distribution. They multiply by division, and this is better seen in buds than in adults; their function seems to be that of formative elements, which serve either to nourish the tissues or to give rise to new cells in developing individuals, helping to form new organs. The muscular fibres are only these cells excessively elongated.

There can be no doubt that in the budding of the ectoproctous marine Bryozoa two distinct and well-developed embryonic layers take a part; the outer one is composed of large cells, in which the tegumentary skeleton is deposited, and the inner invests the cavity of the young bud and furnishes nearly the whole of the organs and tissues of the adult; in consequence of its situation and the part it plays in development it must be regarded as representing the mesodermal layer. In the early stages it forms an epithelium, which does not persist, but is converted into ovicells or aviculariæ, or furnishes the different organs which fill the cavity of the bud; it also provides the materials for the development of the nutritive apparatus. In this last both ectoderm and mesoderm take a share. If it be admitted that the endoderm is wanting, then the epithelial layer which invests the cavity of the young bud ought to be considered as representing both mesoderm and endoderm; from the time of the formation of the gastrula the elements of the inner layer are fused with the internal cellular mass of the embryo.

Morphology of Marine Bryozoa.*—Dr. W. J. Vigelius gives a preliminary notice of his results with regard to the morphology of ectoproctous marine Ctenostomatous and Cyclostomatous Bryozoa. The ectodermal epithelium has been studied by silver preparations of *Bugula*, *Membranipora*, *Flustra*, and *Mimosella*; in the adult of all it consists of large, much-flattened cells, and in the rudiments of the bud of smaller polygonal cells. Contrary to Kohwey, Dr. Vigelius believes that the fine partition-walls which separate the individuals of *Alcyonidium* from one another are perforated, and so correspond to the communication-plates which are so often found in the Ectoprocta.

With the exception of *Alcyonidium* all the forms examined had the parenchymatous tissue developed on one and the same type; and this closely corresponds to what the author has already found in *Flustra membranaceo-truncata* and *Bugula calathus*. The nutrient apparatus is very much the same in all forms; the cilia of the tentacles of preserved specimens were seen to be arranged in the same way as in *Flustra*; *Zoobotryon* and *Mimosella*, in addition to the pharynx, stomach, cæcum, and intestine of other forms, have a masticatory stomach. The circular canal is always found, and is invested by the continuation of the mesenchymatous layer which is found in the tentacular canal; in *Alcyonidium mytili* the author

* Zool. Anzeig., x. (1887) pp. 237-40.

was able to detect within the circular canal, on the anal side, a sharply defined organ, which looked very like a ganglion. The gonads are always products of the parenchymatous tissue, but the size of the ovary and ova varies considerably; in *Flustra carbasea* the spermatozoa-spheres form a compact cell-mass. In *Crisia* the formation of the generative cells appears to go on exclusively in the brood-capsules. The intertentacular organ of *Alcyonidium mytili* is not present in all functional individuals of the colony; it lies beneath the tentacular sheath, has an epithelial investment, and is fused for a large part of its course with the adjacent tentacles of either side.

γ. Brachiopoda.

Anatomy of Brachiopoda Articulata.*—Dr. L. Joubin, who has already investigated the inarticulate Brachiopoda, has extended his studies to *Terebratulina*, *Argiope*, &c. Longitudinal sections of young forms show that the peduncle is a sac which is entirely closed, and is applied against the hind wall of the mantle, an arrangement, therefore, analogous to what obtains in *Discina*. By the aid of figures the author describes the minute structure of the stalk and of its appendages. These latter can only be made out in young forms, as they soon become incrustated. There are a varying number of small yellowish hairs, which terminate by a kind of sucker. The hairs are hollow, and the walls are formed of a series of zones arranged concentrically round a lumen. Each hair is fixed in the thick layer of cartilaginous tissue which forms the end of the peduncle. In function they appear to be comparable to the byssus threads of lamellibranch molluscs, but in their mode of development, and their morphological relations, they are altogether different.

Cæcal Processes of Shells of Brachiopoda.†—Prof. W. J. Sollas adduces evidence that the so-called cæcal processes of the shells of Brachiopods are sense-organs; they are obviously composed of epithelial cells, and in their centre they show traces of an axial fibre, which can be seen to be continuous with the nerve-cells of the mantle. At the outer end of the tubule there is a single large finely granular cell, with a large oval nucleus and spherical nucleolus, and there may be, in addition to it, a number of other nuclei. The inner end of the terminal cell appears to be prolonged into a fibril, which can sometimes be traced into continuity with both the nucleus and the axial fibre. The cæcal tubes of *Waldheimia cranium* are, therefore, epidermal outgrowths with a large terminal granular cell, which is continued proximally into a nerve-fibril and is covered distally by a transparent chitinous layer, separating it from all external influences likely to serve as stimuli except that of light; that, however, the cæcal process is an organ for the perception of light cannot yet be taken as proved, owing, especially, to the absence of anything like pigment in the terminal cells. Specimens better prepared may perhaps add to our information on this point.

Arthropoda.

Relations of Groups of Arthropoda.‡—Prof. C. Claus states that the "essential points" on which he insists are—

(1) He independently supported, eleven years ago, the phylogenetic origin of Scorpions and other Arachnoids from the Gigantostrea.

* Bull. Soc. Zool. France, xii. (1837) pp. 119-26 (1 pl.).

† Scientif. Proc. R. Dublin Soc., v. (1887) pp. 318-20 (1 fig.).

‡ Arbeit. Zool.-Zoot. Inst. Wien, vii. Ct. Ann. and Mag. Nat. Hist., xix. (1887) p. 396.

(2) In 1880 he "implicitly" stated the distinction of the three Arthropod series—Crustacea; Gigantosthraca, Arachnoidea; Myriopoda-Insecta.

(3) His views as to the relation of *Limulus* to the Arachnoidea are quite different from those of Prof. Ray Lankester.

(4) The reference of the Mites to retrograde Arachnoidea, which is supported by the discovery of the rudimentary heart, has been for many years supported on other grounds than those of Lankester.

(5) The hypothesis of the "adaptational shifting of the oral aperture" is perfectly untenable.

(6) And it has nothing in common with the opinion, founded on the conditions of innervation, that the second pair of antennæ of the Crustacea represents the foremost truncal members, while the first pair, like the antennæ of Insecta and Myriopoda, belong to the præstomial part of the head.

a. Insecta.

Some interesting processes in the formation of Insects' Ova.*—Dr. E. Korschelt, as a first of a series of accounts of interesting processes in the formation of the ova of insects, gives a description of an abnormal mode of development in the origin of the egg-rays of *Ranatra linearis*. This may be taken as a supplement to his description of the peculiar mode of formation of the chitin of the so-called egg-rays of *Nepa cinerea*. In that form the egg has at its upper pole seven filamentous appendages—the egg-rays—which serve to bring air to the submerged egg. For this object they are porous at their tip and internally, and this porous substance is connected with a similarly porous layer in the egg-shell. The rays of *Nepa* do not arise in the usual way in which chitin is formed, for they are not cuticular products excreted by the epithelial cells, but are developed within specially modified cells. The allied *Ranatra linearis* has two rays only, but these are longer than those of *Nepa*, with which they agree in internal structure. While the egg-shell proper is developed in the typical mode of chitin formation, the rays are, as in *Nepa*, formed within specially modified cells. The epithelial tissue thickens in the upper lateral wall of the younger ovarian chambers. Owing to this increase in size, the upper wall gets a ridge-like thickening. In the youngest chambers this consists of similar cells, but in those that are a little older the nuclei begin to increase in number. Among the epithelial nuclei of the ordinary size there appear some larger ones, which are already so far altered that they appear to be filled with a number of small chromatin particles. In a more advanced stage the increase in size becomes more marked, and this goes on with age. Plasmatic spaces appear around the larger nuclei, which thus look as though they were surrounded by a cell-body. The increase in the size of the nuclei is accompanied by a multiplication of the cells, and the thickening, within which the rays are to be formed later on, is very different from the rest of the cell-wall. The next process which becomes noticeable is that four of the larger nuclei arrange themselves by pairs, and become almost completely attached to one another. Henceforward these are the cells which grow most, all the other nuclei being left far behind. The histological structure which contains the two nuclei may be well called the double cell. In *Ranatra* it is not so early or so strikingly characterized as in *Nepa*. The chitin of the egg-rays is formed within the double cells between the nuclei, the cell-plasma which lies there being directly converted into the chitinous substance; the ray is first formed at its base, and begins to grow considerably. The cuticula-like layer

* Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 327-97 (2 pls.).

which invests the ray, and which is homogeneous, is not, in *Ranatra*, formed within the double cells, but is secreted by the neighbouring cells in the form of a cuticle; and we have, therefore, the somewhat remarkable phenomena of the union of a rare form of intracellular chitin formation with the ordinary or typical form of cuticular secretion of chitin. The observation of the whole process of chitinization leads the author to the belief that it is due to the direct influence of the nuclei on the activity of the cell. Although the substance given off by the nutrient and the double cells is so different in nature, yet it is impossible to dispute the similarity of the two processes. In both kinds of cells, i.e. in the nutrient cells of Lepidoptera and the double cells of *Nepa* and *Ranatra*, the nucleus extends in the form of amoeboid processes through the cell; and as in both cases a substance is excreted by the cell, it is very probable that the nucleus thus increases its surface for the purpose of increasing the constant action between the nuclear and the cell-substance. It thus exerts a greater influence on the secretory activity of the cell.

The second chapter deals with the exit of the ovum from the ovary, and the fate of the empty ovarian follicle; and with the relation of the egg-forming organ to the efferent apparatus. The result of the investigation of a number of forms is this: the ova always make their exit from the ovarian tube in one typical way, which, however, presents a number of variations due to the characters of the ovarian chamber after repeated ovipositions; the variations may be ascribed to the variations in the form of the ovarian tube, and to the characters of its epithelium. In all cases the egg-chamber is broken through at its base, since here there is always a cellular partition, which opposes the passage of the ova from the ovary into the efferent apparatus; the injury suffered by the tube varies considerably. Sometimes there is not only fissure, but an extension of the constriction at the base of the tube, when the egg passes from the tube into the duct without the connection between the two being broken. In other cases, however, when the epithelium of the ovarian chamber forms a very thin layer, the exit of the ova is accompanied by a destruction of the epithelium, and the consequent breaking up of the whole chamber, of which the tunica propria alone remains; here, of course, the connection between the ovigerous and the oviducal organs is suddenly broken; it is more marked when the constriction between the separate egg-chambers has gone so far, that they are only connected by a thin filamentary piece, for here it is impossible for the ova to pass on; the ovigerous and oviducal portions may in these cases be connected by nothing but the surrounding peritoneal investment; the walls of the emptied egg-chamber fall together, and form isolated balls of cellular substance, until they are absorbed. We have here, it is obvious, to do with a very interesting phenomenon; the true ovary as represented by the oviducal tube is, by a normal act of destruction, separated from the rest of the generative apparatus; in certain cases the ovary again becomes connected with the efferent apparatus, and the solution and reparation of continuity is periodically effected.

In the third chapter, Dr. Korschelt deals with abnormal processes in the development of insects' eggs. In *Reduvius personatus* and *Bombus lapidarius* the lowest ovarian chamber has its wall considerably thickened, as if in consequence of the thickening of the epithelial cells; and the chamber seems at first to have been emptied and to be undergoing retrograde change; closer examination, however, shows that we have to do with a chamber which still contains ovarian rudiments, although altered in condition.

In *Reduvius personatus* the lowest ovarian follicles of some of the tubes

have a thick wall formed of several epithelial layers, the cells of which are quite irregularly arranged, and show signs of degeneration, while there are lacunæ between the cells. The yolk-mass is vesicular and spongy. There can be no doubt that we have here to do with a pathological condition. *Bombus lapidarius* presented just the same phenomena.

The fourth chapter treats of an increase of surface caused by the development of folds on the inner side of the follicular epithelium of *Rhizotrogus solstitialis*; the folds are caused by an invagination of the unilaminar epithelial layer within the egg, and they may extend to the middle of the ovum; when deep there are never more than three; it is to be noted that folds and villi are to be seen on the inner wall of the oviduct. Against the supposition that they are abnormal we have to put the fact that they are found in eggs of all stages and of histologically normal character; nor can they be thought to be due to the faults of preparation. It is possible, then, that the folds are normal and have for their function an increase in the surface of the egg with a view to its better nourishment; with the growth of the eggs the folds disappear. What happens here cannot but remind us of the numerous folds found by Lankester in the cellular egg-capsule of the Cephalopoda.

Polar Globules in Insect Ova.*—Dr. F. Blochmann has shown (1) that in five classes of insects the ovum is never without a nucleus; (2) that in *Musca vomitoria*, in the winter ova of *Aphis aceris*, &c., polar globules are formed; (3) that in some parthenogenetic ova at least only one polar globule is formed, while in the normally fertilized two are present.

In the winter ova of *Aphis aceris* two cells are extruded in normal fashion; the first occasionally gave indications of a nuclear spindle. In two species the summer parthenogenetic ova exhibited only a single polar cell, an observation of some suggestiveness as to the physiological import of these extruded elements.

In *Musca vomitoria* a polar globule formation does indeed take place, but the elements are not extruded. Three results of nuclear division remain for a while in a peripheral thickening, the fourth forming the female pronucleus. Polar globules have now been observed in three classes of insects.

Photogenic Function of Ova of Lampyris.†—Dr. R. Dubois has found that the ova are luminous in ovaries taken from the abdominal cavity of *Lampyris*, and carefully washed immediately after removal; the eggs of both fertilized and non-fertilized individuals are luminous, and the development of the light is in direct relation with the degree of intra-ovarian development of the ova. The luminosity persists in laid eggs until the embryo escapes; the shell abandoned by the larva does not remain luminous, but the creature itself has two luminous organs at the moment of birth; the luminosity of laid non-fertilized eggs does not last beyond a week, and it has been noticed in eggs in which there is no trace of segmentation. The hygrometric condition of the surrounding medium exercises a great influence on the production of the light, which becomes weakened or extinguished as soon as the moss on which the eggs have been deposited becomes a little dry; if the dryness has not gone too far, the addition of a little moisture causes the luminosity to reappear.

Boiling water immediately and alcohol rapidly suppresses the luminosity; eggs washed and shaken in distilled water do not give up their

* Biol. Centralbl., vii. (1887) pp. 108-11.

† Bull. Soc. Zool. France, xii. (1887) pp. 137-44.

luminosity to it; if kept for much more than an hour in water, the eggs begin to lose their photogenic properties; but if withdrawn at such a moment, the light-giving power gradually returns. It is easy to show, as by pricking the egg with a teasing needle, that the substance contained in the shell of the egg is luminous by itself; if parts of the tissue of the luminous organ are rubbed lightly on a sheet of paper there are luminous marks, but nothing of the kind occurs if the shell remains intact.

The photogenic power is exercised in the egg without the aid of tracheæ, nerves, or special anatomical elements, and the continuity of the light is the result of the vital processes of the egg of *Lampyrus noctiluca*.

Senses of Insects.*—M. A. Forel contributes a most interesting and exhaustive account of experiments made by himself and many others on the much discussed problem of the senses of insects.

(1) In regard to *sight* of ants, he notes especially these three conclusions:—(a) They perceive light, and particularly ultra-violet (Lubbock); (b) they really see the ultra-violet rays, without eyes they are almost indifferent to them, and only respond to solar light more or less intense; (c) the dermatoptric sensations are feebler among ants than in the animals which Graber studied.

(2) After reviewing new and old experiments, as to the sense of smell in insects, he notes the following general facts:—(a) In many insects which are essentially directed by sight, as in the Libellulids and Cicadas, the antennæ are rudimentary, and the sense of smell likewise. During the night these insects are passive, while during the day they trust to their power of sight, or possibly in some cicalids also to hearing; (b) the sensitive region, in spite of Graber's protestations, is situated in the antennæ, especially in those parts where the antennary nerve ramifies; (c) in certain insects, as in most Diptera, the antennæ probably serve almost solely for smelling purposes; (d) in other cases, however, where they are mobile, as in the Hymenoptera, they are used for detecting their food or their mates at great distances.

(3) As distinct organs of taste, M. Forel regards the nervous terminations (a) on the proboscis of flies (Leydig), (b) on the jaws and on the base of the tongue (Meinert), (c) on the end of the tongue (Forel), and (d) on the palate or on the epipharynx (Wolff).

(4 and 5) Forel's results as to hearing are as yet too negative to admit of notice. He finally discusses the sense of touch in its various manifestations, and the last chapter of his interesting memoir discusses the relation of the five senses to the general psychical life of insects.

Cell of the Honey Bee.†—Prof. H. Hennessy has a second note on the geometrical construction of the cell of the honey bee; he finds that a sphere may be inscribed within the cell from a point measured from the vertex at a distance equal to the side of one of the lozenges, and with a radius equal to half the long diagonal of this lozenge, while another sphere with a diameter equal to three times the size of the lozenge circumscribes the triangular pyramid at the summit. If D' be the diameter of the inscribed sphere, and D that of the exterior sphere, the relation between them may be expressed thus:—

$$\frac{D}{D'} = \left(\frac{3}{2}\right)^{\frac{3}{2}}.$$

* Rec. Zool. Suisse, iv. (1887) pp. 161-240.

† Proc. Roy. Soc. Lond., xlii. (1887) pp. 176-7.

The relation between the geometrical cell and the interior and exterior spheres may possibly have some bearing on the question of the formation of the actual cells.

Brain of *Vespa crabro* and *V. vulgaris*.*—M. H. Viallanes, in the fourth of his memoirs on the structure and histology of the nervous centres of Articulata, deals with the brain of *Vespa crabro*, and *V. vulgaris*. He divides the brain into three great regions, which he calls protocerebrum, deutocerebrum, and tritocerebrum ("protocerebrum," &c.); the first of these consist of the two optic ganglia, the three ocellar ganglia, and the median protocerebrum. The optical ganglion is almost identical in constitution with that of *Libellula*, and consists of post-retinal fibres, ganglionic layer, external chiasma, external medullary mass, internal chiasma and internal medullary mass. The optic nerve connects the ganglion with the median protocerebrum, and is composed of four perfectly distinct bundles, two of which are superior and two inferior; of the latter, one is very large, and is formed of two distinct cords. The ocellar ganglia are found beneath the ocelli; each consists of a mass of dotted substance, which is fairly homogeneous, and has connected with it small nervous cells, in which the protoplasm is much reduced. The median protocerebrum is made up of two pedunculated bodies, two cerebral lobes, and a central body. The first of these consists of the internal and external calyx, together with the stalk; the elliptical calyces have their walls formed of a thick layer of dotted substance, and both their internal and external surfaces are invested by a thick layer of small nerve-cells. Five parts are to be distinguished in the peduncle, the stalk of which is united to the substance of the cerebral lobes by two large fibrous bundles. The central body, although consisting almost exclusively of dotted substance, has a complex structure; it enters into relation with nearly all the constituents of the protocerebrum, fibres extending to the cortex, to the calices, to the cerebral lobes, the œsophageal commissure, and the olfactory lobes.

The two cerebral lobes are intimately connected beneath the central body; they are essentially formed of dotted substance, among which are a large number of fibrous bundles with definite courses; the connection between the lobes is effected by two commissures, one superior and one inferior; the œsophageal commissures are very voluminous and are continuous with the cerebral lobes; they also consist of a very homogeneous dotted substance, among which are a few bundles of well-marked fibres. Attached to the protocerebrum is a special organ which the author calls the wings of the cerebral lobe; it is entirely formed of dotted substance, and is everywhere surrounded by ganglionic cells.

The cerebral lobes are themselves everywhere surrounded by nerve-cells arranged in layers, which are thickest behind and in the median region; the prolongations which they give off pass to the central body, to the stalk of the pedunculated body, and to the olfactory lobe, as well as to the cerebral. The deutocerebrum is represented by the two olfactory lobes, each of which has the form of a rounded projection, attached by a short stalk to the anterior face of the corresponding œsophageal commissure. The structure is very characteristic; the central part is formed of somewhat loosely arranged dotted substance, and the cortical consists of a layer of olfactory glomeruli; each of these last has the appearance of a small sphere of dotted substance, and is united to the central part of the lobe by a short peduncle which is formed of the same substance. The outer face of the olfactory lobe is invested by a thick layer of small cells altogether similar

* Ann. Sci. Nat., ii. (1887) Art. No. 1, 100 pp., 6 pls.

to those which invest the calices; the prolongations which they give off are grouped into bundles which make their way among the olfactory glomeruli, and are lost in the central dotted substance of the lobe. In the pedicle there are fibres and dotted substance; the antennary nerve is composed of two bundles. The tritocerebrum, unlike what happens in some insects, notably the Orthoptera, is fused with the neighbouring parts, and can only be distinguished by the point of origin of the common trunk of the nerve for the labrum and the stomatogastric nerve.

Life-history of *Ugimya sericaria*.*—Prof. C. Sasaki gives an account of the life-history of *Ugimya sericaria*, the Dipteron whose larva plays terrible havoc among the silk-worms which are raised in Japan in May and July. After describing the external and internal anatomy of the adult fly, in which particular attention is given to the structure of the generative organs, the development of the maggot is considered; the greater number of eggs are laid in May, and deposited on mulberry bushes, with the leaves of which they are eaten by the silkworm; owing to their small size and hard chitinous covering they are not crushed by the strong jaws of the silkworm, and pass uninjured into the digestive tract. In one to nine hours the shell breaks open by a longitudinal slit on its flat surface; the escaped maggot is invested in a thick transparent oval sac, which soon opens at one end, when the tiny creature becomes free. After one to eight hours the maggot, probably by the aid of its hooked jaw, passes through the wall of the canal and enters directly into the ganglia which lie close beneath; ordinarily the silkworm is now weakened, and its body presents an unusual aspect from the severe irritation of the nervous system. The appearance produced may be understood from the popular name of "swelled segment" which is given to the disease. Feeding on the ganglion-cells the parasite grows larger and larger; after about a week it passes into the body and "directly searches for the portions of the tracheal system of its host where the stigmata open." Here it forms a sort of cup by heaping up the fats and muscular fibres of its host round the opening made on entering, and sticking them together with its saliva; it now feeds entirely on fat. The presence of a dark brown or blackish patch round the stigma is conclusive evidence of the presence of the parasite. In addition to the disease mentioned, other diseases and symptoms may be caused by the presence of the maggot.

When it reaches maturity the maggot leaves its abode in the body of the silkworm or its pupa, and, making a hole in any part of the body of its host, it passes into the cocoon, and thence to the outer world. The author describes in detail the habits and anatomy of the mature maggot, the structure of the pupa, and its development into the mature insect, and concludes a very interesting essay by some suggestions as to the protective methods which should be adopted. It is interesting to note that the pupa of this fly is itself infested by a parasitic mite, which probably belongs to the genus *Tyroglyphus*.

Pedigree Moth-breeding.†—In order to obtain new data for verifying certain important constants in the general theory of heredity, Mr. Francis Galton proposes to experiment on moths, more especially on those which are double-brooded. He points out the advantages, such as the short lives, no change in length of wing, and ease of rearing and preserving, &c., to be obtained by using moths as subjects.

It is intended to start from a brood of a single pair of moths, and to

* Journ. College of Science, Imp. Univ. Japan, i. (1886) pp. 1-46 (6 pls.).

† Trans. Entom. Soc. Lond., 1887, pp. 19-28.

trace the changes of some one characteristic, e. g. length of wing, during several successive generations. Three lines of descent will be contrasted, viz. shortest winged, longest winged, and medium winged, in each generation.

For measuring the length of wing of living moths, he proposes a pair of scissor-like compasses, with arms on one side of the joint, being five times the length of those the other side, and the long arms furnished with an index marked in $1/2$ millimetres. He has also tried the glasses from one of the tubes of an opera-glass, with a lengthened interval between them, so as to form a Microscope of very long focus, say 18 in. This was fixed to a light rod that carried a millimetre scale, set across its free end, at a trifle less than 18 in. from the object-glass. On approaching the scale to within half an inch of any small object, that object and the scale are both in fair focus at once, and they are sufficiently far from the eye to render any error (arising from slight change in position of the eye) of little or no importance.

For accurate measurements of dead moths, Mr. Galton has a much better instrument under construction, in which there is a small Microscope with cross wires, in the short limb of a pentagraph, the long limb being used both for setting the Microscope and for reading off the measurements.

The author then details his method of centering the measurements, by means of a curve through the ends of ordinates, such as he has used in other measurements.

Histology of Enteric Canal of Insects.*—M. V. Faussek has observed in *Eremobia muricata* the same kind of glandular structures between the cells of the cylindrical epithelium of the midgut, to which Frenzel has applied the name of glandular crypts. They have the form of narrow-necked flasks, and are filled by a mass of closely applied nuclei, which do not differ essentially from the nuclei of epithelial cells. The hind-gut consists of two sections, connected with one another by a delicate coiled tube. This has a strong muscular layer, and is lined by an epithelium, which consists of very small cells, is raised up into folds, and provided with a thick intima. On the contraction of the muscular elements, these folds must close the lumen of the tube. In the portion of the tract which lies above the connecting tube, the epithelium consists of long broad cells, with very large nuclei, each of which is surrounded by a transparent area. The other part of the tract is occupied by six longitudinal ridges of the epithelial layer—the so-called rectal glands. In the epithelium of these there are two kinds of cells, some being higher and cylindrical, others less distinctly marked and mucous. The nuclei of the latter are of small size, and each occupies the centre of a clear vesicular space. The space between the epithelial layer and the musculature is filled by a loose fibrous connective tissue, the limits of the separate cells of which are not preserved. The tracheæ branch in this tissue, and fine ramules make their way between the epithelial cells, and end in small blind enlargements.

Some interesting observations were made on the structure of the hind-gut in larvæ of *Æschna* and *Libellula*. The muscular layer is feebly, but the epithelial well developed. The latter consists of two kinds of cells in different regions. Some are large and cylindrical, with large granules, and these form folds, into which enter pretty thick tracheal branches. This kind passes gradually into the second, in which the cells and their nuclei are small; and the protoplasm does not stain with carmine. The layer formed by these is arranged in numerous complicated folds, and appears in cross

* Zool. Anzeig., x. (1887) pp. 322-3.

section as if it were made up of gland-like cell-complexes. The enteric gills are irregularly invested by two kinds of epithelium; in the terminal portion of the hind-gut the enteric gills disappear, and are replaced by typical rectal glands, the presence of which speaks in favour of Chun's supposition that the rectal glands are not structures which have been altered by disuse.

Glandular Secretion of free Iodine.*—Dr. J. C. C. Loman found that, on keeping for five days a specimen of the rare beetle *Cerapterus 4-maculatus*, a distinct odour of iodine was perceptible. This was excreted in drops, and when tested by ether, alcohol, and starch, found to be truly iodine. The iodine was found, on dissection, to be secreted by the anal glands. These, as in other species of Coleoptera, consist of two extremely fine coiled tubules, provided with a pyriform lateral swelling. The walls of this are thickly covered with muscular tissue; and it may be regarded as a reservoir or propulsive organ. The function of this secretion appears to be defensive.

Modification of Habits in Ants through fear of Enemies.†—Dr. H. C. McCook observed a raid of *Formica sanguinea* on a nest of *F. fusca*, which proved a failure. The instinct for kidnapping has appeared to develop, on the part of those who are the victims, a corresponding strengthening of instinct in the way of concealment. When the latter are not exposed to the acts of the former, they raise above the surface of the ground a mound of more or less considerable size, and over its summit and at the base the gates are scattered without the least attempt at concealment. But when a colony of their enemies is near, they omit or subdue elevations above the surface, their gates are few and cunningly concealed, and quantities of rubbish are scattered around, with the evident intention of hiding the locality of their nest, or making the approach to it more difficult. A similar faculty has been observed in *F. schaufussi*.

Vesicating Insects.‡—Continuing his monographic researches on Meloidæ, M. H. Beaugregard discusses the spermatogenesis, and the various external and internal structures associated with the reproductive system.

1. *Spermatogenesis*.—On the internal wall of the testicular tubules (*a*) large cells are seen with spherical nucleus, and among these (*b*) small spherical groups of four or six cells of pyramidal form, and arranged in stellate fashion, with convergent summits. These groups of small cells arise from the division of the larger. The cells of the groups multiply by division, and not by budding, and form the spermatid spheres described by Balbiani. The final result of division is the formation of what Beaugregard calls "spermatoblasts," each of which gives origin to a spermatid filament. The spermatid sphere is from the first to last enveloped in a fine protoplasmic layer with a nucleus. This is due to one of the original halves of the male ovule, the other half, of course, dividing to form the "spermatoblasts." The further ontogeny of the sperms is traced, and notice is taken of the relevant observations of Gilson and Wielowieyski.

2. *The external male organs* are next described in a number of typical forms. The bivalved copulatory apparatus, with the groove surrounding the penis, is also described in detail.

3. *Female apparatus*.—The third part of the memoir discusses the various structures which make up the female organs. These do not differ in any marked feature from those usually found in Coleoptera. M. Beau-

* Tijdschr. Nederl. Dierk. Ver., i. (1886-7) pp. 106-8.

† Proc. Acad. Sci. Philad., 1887, pp. 27-9.

‡ Journ. Anat. et Physiol., xxiii. (1887) pp. 124-63 (6 pls.).

regard distinguishes two groups—(1) those in which a seminal reservoir and accessory gland are present; (2) those in which the accessory gland is absent, and the seminal reservoir approximated to the orifice of the oviduct. The female genital armature formed from the ninth urite is then discussed, with special reference to the conclusions of Lacaze-Duthiers. The histological details of M. Beauregard's careful investigations are hardly adapted for compressed summary.

Fossil Insects.*—Dr. S. H. Scudder gives a systematic review of our present knowledge of fossil insects, including myriopods and spiders. It is essentially a translation for the benefit of English readers of the text furnished by the author to Dr. Zittel for his 'Handbuch der Paleontologie.' The German text, however, is accompanied by more than two hundred illustrations. M. Barrois is also publishing a French version. Each section of the work is accompanied by a complete bibliography, which shows at a glance how recently this department of paleontology has been developed (very few of the titles dating back beyond 1850), and how extensive and varied the author's own contributions have been. The concise descriptions of the classes, orders, and families are accompanied by brief notes on the fossil genera and species, with the locality and geological horizon in many cases; while the stratigraphic distribution and range of each order are shown by tables giving the number of species found in the rocks of each age. No fewer than 2600 species of true insects have been found fossil up to the present time. The great majority of these, as well as of myriopods and arachnids, are from the middle tertiary. This great irregularity in the chronological distribution of the fossil forms, which is, of course, due largely to the character of the deposits, is a plain indication that important insect fauna still remain to be discovered. Thus, of the fossil spiders, 31 forms are known from the palæozoic strata, 1 from the mesozoic, and 285 from the tertiary, the great majority of the tertiary forms having been found in the amber deposits of Prussia.

γ. Prototracheata.

Development of Cape Species of *Peripatus*.†—Mr. A. Sedgwick commences his third memoir on the development of *Peripatus* by a brief reference to the criticisms and arguments of Dr. Kennel. In the ectoderm there appear lateral thickenings, which are continuous from somite to somite; the ventral part of these gives rise to rounded elements, which go to form the nervous system; the elements are formed first in the preoral region and then in the lateral cords; or, in other words, the nervous system, at its very first appearance, begins in front of the mouth, where it is continuous across the middle line, and it extends backwards, continuously, on either side; the central ganglia give rise directly to the eyes and tentacular nerves, the portions around the mouth become the circumoral commissures, and the hinder portions are the rudiments of the ventral nerve-cords of the adult. A distinction must be drawn between the true body-cavity and the large apparent body-cavity, which may be called the pseudocœle or vascular space; the adult body-cavity comes entirely from the pseudocœle, and both heart and pericardium are pseudocœlic; the only products of the enterocœle cavity are the nephridia and the generative glands with their ducts; neither in the embryo nor in the adult do the nephridia open into the pseudocœle, but into a vesicle in each appendage which has been hitherto

* Bull. U.S. Geol. Survey, No. 31. Cf. Science, ix. (1887) p. 426.

† Quart. Journ. Micr. Sci., xxvii. (1887) pp. 467-550 (4 pls.).

unnoticed. These characters, when taken with the peculiarities of arthropod organization—the feeble development of the somites, the apparent absence of nephridia, the vascular character of the pericardial cavity, and the possession by the heart of lateral ostia opening into the pericardium—are of great morphological interest.

Developing, later on, the general results which follow on the pseudocœlic character of the body-cavity, Mr. Sedgwick defines a cœlom as a cavity which (1) does not communicate with the vascular system, (2) does communicate by nephridial pores with the exterior, (3) gives rise by its lining to generative products, and (4) developes either as one or more diverticula from the primitive enteron, or as a space or spaces in the unsegmented or segmented mesoblastic bands. Now the vascular space has none of these characters; it developes either from the blastocœle or from a system of channels hollowed out in the mesodermic tissue of the body. In Annelids and Vertebrates the two spaces co-exist; in the Arthropoda it is very probable that the cœlom persists as the gonads and their ducts, but for the most part vanishes, giving rise possibly to glands of a doubtful nephridial nature, while the body-cavity and vascular system have an exclusively pseudocœlic origin; in the Mollusca the cœlom and vascular space have not been sufficiently distinguished from one another; there seems, however, to be no doubt that the pericardial cavity of the Lamellibranchiata and Gastropoda represents the entire cœlom, for it is always shut off from the vascular system, and it communicates with the exterior by a pair of nephridia. The considerations urged as to the distinctness of cœlom and vascular system do not, at present, seem to apply to the Nemertinea or Hirudinea.

In most animals the vascular space or pseudocœle appears before the cœlom, but in *Peripatus* the cœlom appears first; in arthropods, at least, the vascular space is in the early stages very commonly occupied by yolk, while the cœlom is entirely free from it; there may be, therefore, some connection between the vascular and the enteric spaces.

The true cœlom of *Peripatus* appears in the ordinary manner as a series of cavities, one in each mesoblastic somite; these, which are at first ventrolateral in position, soon acquire a dorsal extension, and the contained cavity becomes divided into a ventral part, which passes into the appendage, and a dorsal part, which comes into contact but does not unite with its fellow of the opposite side on the dorsal wall of the enteron. The dorsal portions soon become obliterated in the anterior part of the body, but posteriorly they unite with those of their own side to form the generative tubes. The ventral portions retain their isolation throughout life, and give rise to a coiled tube, which is the nephridium of the adult, and a small vesicle which is contained in the appendage, and constitutes the internal blind end of the nephridial portion of the somite. The body-cavity consists of four divisions—a central compartment which contains the intestine and gonads, a pericardial cavity, lateral compartments containing the nerve-cords and salivary glands, and the portion in the appendage.

If it is true, as is likely, that the cœlomic relations of other Arthropods are similar to those of *Peripatus*, we may add to the definition of the group the terms—cœlom inconspicuous, body-cavity consisting entirely of vascular spaces; while in Vertebrates and most Annelids the body-cavity is entirely cœlomic, and the vascular spaces are broken up into a complicated system of channels, and in Mollusca generally the pericardium alone is cœlomic, and the vascular spaces are represented by the heart and the more or less complicated system of spaces in the body.

Mr. Sedgwick enters with some detail into the incomplete segmentation

and syncytial nature of the embryo, as to which he has already made some remarks. *Peripatus capensis* is remarkable, even if not unique, among animals for the large size of its egg, combined with the almost complete absence of yolk; the history of its segmentation shows that at no period of development are the cells which arise from that segmentation completely isolated units; on the other hand it is quite certain that in small holoblastic eggs the cleavage is complete, and the question naturally arises, is the complete or the incomplete cleavage phylogenetically the more correct. In answer to this we may observe that no animal is composed of a mass of separate and similar cells, that complete cleavage is probably very much rarer than is generally supposed; when such a cleavage does take place it may possibly be due to "an intensely active force in the centre of the cell, which compels for the moment the assumption of this (clean rounded) form in the protoplasm over which it has dominion." The phenomena of segmentation in the ova of various Crustacea suggest that it may be possible to find a purely mechanical explanation of complete cleavage. The supposition that the ancestral Metazoon was a colonial Protozoon is not supported by holoblastic segmentation, but is somewhat favoured by what we know about incomplete cleavage.

The view, however, which is in accordance with the facts of development of *Peripatus capensis* is the old doctrine that the ancestral Metazoon was a multinucleated infusorian-like animal. But this view is, after all, only "a more or less plausible suggestion without any strong basis in fact." Mr. Sedgwick proceeds to criticize the speculations of Metschnikoff, and points out certain difficulties and misunderstandings; the chief point in which they disagree is that Mr. Sedgwick cannot accept the view that the hollow blastula is a primitive form, or that the formation of the endoderm by migration inwards of the cells is a primary process. Attention is directed to the fact that the formation of mesoderm in *Peripatus* is essentially a formation of nuclei which pass to their respective positions and arrange themselves in the protoplasmic reticulum there present, and to the observation that the primitive streak is the growing point of the animal, from which almost all the tissues of the adult are derived; its nuclei, therefore, are not merely mesodermal, but are also ectodermal and endodermal.

5. Arachnida.

Morphological Significance of so-called Malpighian Vessels of two Spiders.*—Dr. J. C. C. Loman has made transverse sections through the hinder part of the body of a *Cteniza* from West Java, the examination of which shows that the two excretory ducts are appendages of the midgut; similar relations have been observed in *Epeira*, *Tegenaria*, and *Mygale*. Other points of difference between these ducts and the Malpighian vessels of insects are to be found in (1) the structure of the separate cells, which in spiders are of the type of enteric epithelial cells, and (2) as to their function, for the contents of the spider's ducts are fluid, and their slight contents are by no means of the character of renal concretions; uric acid and uric salts were wanting.

The resemblance of these tubes to the tubular excretory organs which have been shown by Spencer to be connected with the midgut in *Oniscus*, *Gammarus*, &c., is another indication of that connection between the Arachnida and the Crustacea rather than the Insecta, which recent studies have gone so far to support.

* Tijdschr. Nederl. Dierk. Vereen., i. (1886-7) pp. 109-13.

Chorioptes (or Symbiotes) on Birds.*—M. L. Trouessart, remarking that *Sarcoptes* is the only acarid that has yet been certainly found on birds, now directs attention to the discovery by MM. Rivolta and Caparini on fowls, of two acari which they call *Epidermoptes bifurcatus* and *E. bilobatus*; the latter is synonymous with *Symbiotes avium*; these creatures appear to the naturalists just named to be the cause of grave attacks of psoriasis.

M. Trouessart, however, agrees with M. Neumann, that the psoriasis is rather due to *Achorion Schönleini*, and thinks that the figures given of *Epidermoptes* show that that genus has not the form either of rostrum or of limbs which is proper to the fossorial habits of the psoric species, and that its facies is that of a plumicolous sarcoptid.

On *Passer domesticus* there lives, as there probably does on a number of other birds, a species which certainly belongs to the genus *Chorioptes* (Gervais) or *Symbiotes* (Gerlach); it is found at the point of insertion of the primary feathers, and does not seem to penetrate deeply into the skin; it is proposed to call it *C. avus*. On *P. domesticus* there is a very small *Pterotichus* which may be called *P. dermicola*, as it lives under the skin of the body.

Sarcoptes lævis.†—Prof. A. RAILLET gives an account of a new acarid found parasitic on the pigeon and the fowl. This new species is very closely allied to *Sarcoptes mutans*, but appears to differ in having only one larva at a time; it is also smaller than *S. mutans*, though larger than *S. fossor*; it approaches the latter, and differs from the former species by the absence of cutaneous papillæ on the notogastrium of the female. The most important character, however, is the presence of two copulatory suckers on the male, for this is a very exceptional, though not unique, possession in the genus *Sarcoptes*. The mode of life of this new species shows that the name of plumicolous Sarcoptidæ is not exclusively applicable to the Analgerinæ, for *S. lævis* lives in the follicles of feathers. The author is of opinion that the presence or absence of copulatory suckers in a given form is not sufficient to justify the creation of a new genus, or even of a special section of an old genus.

Stage in the Development of Galeodes.‡—Herr A. CRONEBERG describes a somewhat remarkable stage in the development of *Galeodes araneoides*; the spherical abdomen forms the chief mass of the contents of the egg and the broad and flattened cephalothorax with the folded palpi, and the legs are pressed down on the lower surface of the abdomen. The appearance of young which have just escaped gives the impression of a contraction of the abdomen having driven part of the fluids contained in it into the anterior part of the body, the appendages of which have thereby become suddenly extended; the abdomen is now seen to be of an elongate egg-shape, and to have some slight constrictions. The cuticle is shown to be provisional by the complete absence of all the setæ and hairs which are so numerous in the adult; along the back alone is there a double row of twelve setæ. The appendages have as yet no distinct sign of segmentation, and there are no indications of the abdominal limbs. The rostrum is stout and broad, and is completely devoid of the complicated setal apparatus at its tip; the highly chitinated pharynx is provided with projecting chitinous ridges, and so calls to mind the structure of the Pseudoscorpions. Most remarkable is the presence of a pair of flat, wing-like appendages, about 0.5 mm. long, which are inserted on either side of

* Comptes Rendus, civ. (1887) pp. 921-3.

† Bull. Soc. Zool. France, xii. (1887) pp. 127-36 (1 pl.).

‡ Zool. Anzeig., x. (1887) pp. 163-4.

the cephalothorax in the space between the first and second pairs of feet; they are situated, however, very much higher than the feet, and there are no signs of them in the adult. It is difficult to say what these provisional organs mean, but they may perhaps be best compared with the paired appendages found in the embryo of *Asellus*. In *Galeodes* they are invested in a distinct cellular layer, which is altogether identical with the matrix of the general body-covering, but which does not contain tracheæ, nerves, or muscles.

As there was not, in the stage observed, any indication beneath the cuticle of the various appendages which are permanently connected with the skin, it is probable that the Galeodidæ live for a time in this pupal condition after escaping from the egg.

e. Crustacea.

Parasitic Castration and its influence on the External Characters of male Decapod Crustacea.*—Prof. A. Giard has found that *Sacculina Fraisei*, which is parasitic on *Stenorhynchus phalangium*, so acts on the males as to give them very much the appearance of females; indeed, if one neglects to lift the caudal appendage and observe the position of the genital orifice there is some difficulty in determining the sex. Similar modifications were observed with young males of *Portunus holsatus* infested by *Sacculina Andersonii* (sp. nov.), and less considerable modifications were detected in other species. The Bopyridæ which infest young Decapods bring about similar results, and Perez has noticed a case of parasitic castration in the hymenopterous insects of the genus *Andrena* which is infested by *Stylops*. The author discusses the results arrived at, and comes to the conclusion that the modifications due to parasitic castration must be assimilated to those which are the result of progenesis—progenesis obtaining when sexual reproduction occurs in a more or less precocious manner, the products being matured before the creature has attained its full development.

In addition to their intrinsic interest the observations of Prof. Giard have an important bearing on the question of the value of the older statistics with regard to the Rhizocephala; the date of fixation of the parasite may be approximately fixed by the knowledge of the fact that the modification of the external sexual characters is the result of the profound lesion of the genital glands. The fact that a parasite provokes in its host an abnormal development of organs which protect it at the expense of its victim seems at first sight very exceptional, but it is to be regarded as a mutual adaptation which is not without analogy with numerous facts of symbiosis, while the deformations produced in various plants by the Cecidomyiæ or the Cynipidæ are phenomena of exactly the same kind; a curious case is that of the white campion (*Melandryum album*) which is infested by *Ustilago antherarum*; when the parasitic fungus is developed on a male plant it fructifies in the stamens, when it falls on a female the stamens, instead of remaining rudimentary, become completely developed just as the male *Stenorhynchus* widens its abdomen to protect the *Sacculina Fraisei*.

Palæmonetes varians.†—M. T. Barrois gives a careful account of the characters of *Palæmonetes varians* Leach, and discusses its geographical distribution. As to the somewhat anomalous characters of the latter the following explanation is offered; in earlier times the ancestors of existing

* Bull. Sci. Dep. Nord, x. (1887). Cf. Ann. and Mag. Nat. Hist., xix. (1887) pp. 325-45.

† Bull. Soc. Zool. France, xi. (1887) pp. 691-707 (1 pl.).

lacustrine forms inhabited fjords and more or less deep bays which gradually lost their communication with the sea; the waters, which became less and less saline, were finally quite fresh, but they retained such of the animals as were able to adapt themselves to the new conditions of existence; it is because of this process that we find the same species in the sea as in fresh-water lakes.

Phylogeny of Bopyridæ.*—MM. A. Giard and J. Bonnier, limiting themselves for the present to European Decapoda, point out that each species of these Crustacea may have two or three distinct parasites; the Bopyridæ parasitic on the Decapoda may be divided into three groups—abdominal, branchial, and visceral parasites; analogous cases may be cited among the Branchiobdellidæ of the crayfish and the Cestridæ of deer and horses.

These facts, incomprehensible on the theory of the fixity of species, seem to show that several states of symbiotic equilibrium have been successively realized; by the aid of development these can be traced in the case of the Bopyridæ.

The first larva is very uniform throughout the group, and its long pelagic existence shows us that the ancestors of the Bopyridæ were free forms; by the whole of its organization it approaches the Cægidæ, and more particularly *Eurydice*. The second larva is of the *Cryptoniscus*-stage, and it is now that the parasitic life begins; in the *Cryptoniscidæ* the male is arrested in its development at the second larval stage, but in the other Bopyridæ it takes a more or less *Idothea*-like form.

The singular coexistence of parasitic Cirripedes in all the types of Decapods infested by the Bopyridæ leads us to suppose that the Bopyridæ have been introduced into the Decapoda by the Cirripedia Rhizocephala; while the members of one branch of the *Cryptoniscidæ* have remained faithful to their first host, another branch has become adapted for direct parasitism on the Decapoda, and has given rise to *Phryxus*, *Bopyrus*, and the *Entoniscidæ*. The presence of a phryxoid stage in the development of most female Bopyridæ shows that the genus *Phryxus* may be regarded as the stock whence many have issued.

Muscular Fibres of Edriophthalmata.†—Dr. R. Kœhler has investigated the mode of grouping of the contractile elements in the muscle-fibres of Isopoda and Amphipoda, as well as their relation to the cells from which they are developed. A large number of forms were examined. The contractile substance occupies the central region of the primitive bundle, while the protoplasm not differentiated into fibrils forms a peripheral envelope. It may form a layer more or less thick, but its situation in relation to the contractile element is always the inverse of that which is observed in the muscles of other animals. The variations in the different forms concern the size of the muscle-cells and primitive cylinders, the number of the cylinders, the form, development, and relative importance of the contractile element, and finally the number, size, &c., of the nuclei. The size of the muscle elements is not proportionate to that of the animal. As regards the above variations, Amphipods are much more regular than Isopods.

Copepod Parasite of Amphiura squamata.‡—M. A. Giard describes the female, male, and young forms of *Cancerilla tubulata* Dalyell, which he found at Fécamp as a very abundant parasite on *Amphiura squamata*.

(a) The female, which is generally fixed to the oral face of the disc, at the base of a ray, with its head towards the mouth, has a triangular form,

* Comptes Rendus, civ. (1887) pp. 1309–11.

† Journ. Anat. et Physiol, xxiii. (1887) pp. 113–23 (1 pl.).

‡ Comptes Rendus, civ. (1887) pp. 1189–92.

due to the presence of two egg-sacs as large as the body. The form and appendages are described.

(b) The male, which is much rarer and decidedly smaller, resembles a *Cyclops*. It differs markedly in the structure of the first and second thoracic appendages.

(c) Reproduction goes on from May to September; two or three egg-laden females may occur on one *Amphiura*; the segmentation is total and unequal; the gastrulation epibolic; the embryo a nauplius. The young forms fix themselves to the extremities of the arms of the *Amphiura*, and approach the disc as they grow.

In most of its characters, *Cancerilla tubulata* approaches *Ascomyzon echinicola* Norman, a parasite of *Echinus esculentus*, and *Asterocheres lillyeborgii* Axel Boeck, a parasite of *Echinaster sanguinolentus*. Its buccal armature connects the Pœcilocostomata with the Siphonostomata, and M. Giard proposes to unite the Lichomolgidae Kossmann (Sapphirinidae Brady), the Ascomyzontidae Axel Boeck (Artotrogidae Brady), the Bomolochidae Claus, and the Ergasilidae Claus, in a single group of Coryceidae.

Vermes.

a. Annelida.

Origin of Excretory System of Earthworms.*—Prof. E. B. Wilson, who has studied the development of *Lumbricus olidus*, finds a remarkable similarity between the development of its nephridia and the origin of the excretory system in Vertebrates. Of the eight large cells at the hinder end of the embryo two are nephroblasts; from each cell a row of cells extends forwards on the ventral side of the body; the rows are at first one cell wide, but become solid cords, several cells in thickness; in each somite a solid outgrowth from each nephridial row projects into the coelom, and is ultimately converted into a nephridium; as these organs arise as metameric outgrowths from a solid cord of cells that lies in the somatopleure, their mode of development is essentially similar to that of the vertebrate pronephros. The nephroblast is originally an ectoblastic cell, and later sinks below the surface. Hatschek, Meyer, and Lang have called attention to the close resemblance between the Wolffian ducts of vertebrates and the longitudinal canal that unites the nephridia of the larval *Polygordius* and some adult annelids; the present results supply the embryological proof of the homology of the two structures, and show that the excretory system of annelids and vertebrates are constructed on fundamentally the same type, and originate by similar modes of development.

Polychæta of Dinard.†—M. le Baron de Saint-Joseph deals in this first portion of his memoir with the Syllidae; in his introduction he speaks of the importance of examining Annelids in the living condition, pointing out that large species can only be preserved in alcohol, which destroys their colours and contracts their tissues, while all the media in which smaller forms are mounted have their inconveniences. The best—or, rather, the least objectionable—is Langerhans's fluid, which consists of five parts of gum arabic and five of distilled water, to which, after twenty-four hours, are added five parts of glycerin and ten of a five per cent. solution of phenic acid; before being put in this the worm should be plunged in a one per cent. solution of chromic acid, which kills it without causing so much contraction as alcohol.

* Proc. Acad. Nat. Sci. Philad., 1887, pp. 49–50.

† Ann. Sci. Nat., i. (1887) pp. 127–270 (6 pls.).

Five different modes of reproduction are known among the Syllidæ:— (1) By direct reproduction, as in a number of forms. (2) By alternate generation and fission, and then by budding from a single stolon, as in *Syllis hamata*, *S. Krohnii*, and others; the stolones of the different genera always differ from the stock, and they differ also among themselves in the forms of their heads, of which there are four distinct types, that of *Syllis amica*, that of *Chætosyllis*, of *Tetraglene*, and of *Ioida*. (3) There may be reproduction by successive alternating generations, at first by fission with a single stolon, then by budding with a single stolon, and lastly by budding with several stolons in a chain, all the chains having for males the forms of *Polybostrichus*, and for females that of *Sacconereis*; here we find *Autolytus*, *Myrianida*, *Virchowia* (?), and *Procerastea* (?). Viviparous reproduction has been proved in two cases only, in *S. vivipara* and *S. incisa*. (5) Reproduction by lateral gemmation occurs in *Syllis ramosa*, where the stolones have the form of *Tetraglene*. There are as yet a number as to the mode of whose reproduction we are still ignorant. The descriptions of the species commence with that of *Syllis hamata*, under which must be included the varieties regarded by Czerniavsky as specifically distinct. *S. variegata*, *S. prolifera* are followed by *S. alternosetosa* sp. n. which is extremely common; its head is provided with four small eyes without a crystalline lens, the setæ are of various kinds, and remarkable for their complete alternation. *S. æsthetica* is also a new species characterized by the form of its setæ. Under *S. gracilis* Czerniavsky has distinguished four species, which must be united. *Pionosyllis* is accepted with the emendations of Langerhans. *P. longocirrata* sp. n. is distinguished by having the dorsal cirri of the anterior segments excessively long; transparent organs terminating in a cæcum surround the proboscis; the author is unable to ascribe any function to these long tubes, of which there are ten. *P. lamelligera* sp. n. is in some respects intermediate between *Pionosyllis* and *Eusyllis*, having, like *E. lamelligera*, the first ventral cirrus lamelliform and two glandular tubes attached to the sides of the proboscis. *Syllides longocirrata* is redescribed. *Eusyllis* is regarded as the bond of union between *Pionosyllis* and *Odontosyllis*, and nearer the former; the five species found at Dinard—*E. lamelligera*, *E. monilicornis*, *E. blomstrandii*, and *E. intermedia* sp. n.—are all fragile and phosphorescent. Four species of *Odontosyllis*, of which *O. polyodonta* sp. n. has a very large number of small teeth, are mentioned. The possession of a large conical tooth must be added to the definition of the genus *Trypanosyllis*, which is represented at Dinard by two species. *Pterosyllis spectabilis* is carefully described; this species often has its body and long dorsal cirri covered with *Trichodina Auerbachii*, and a curious marine infusorian which was described but not named by Claparède; it may be called *Ophryodendron annulatorum*. *Eurusyllis paradoxa* in its various stages is described.

Grubea clavata, *G. pusilla*, *Sphærosyllis hystrix*, and *S. erinaceus* are described. With regard to Langerhans's supposition that *Pædophylax* exhibits alternations of generation, Baron de Saint-Joseph expresses the opinion that the German naturalist based his view on animals which had lost their proboscis and proventriculus. Seven phases of *P. claviger* are described.

The genus *Autolytus* must include *Proceræa* and *Stephanosyllis*; the author gives an emended definition. *A. paradoxus* sp. n. is distinguished by having, from the third segment, the dorsal cirri alternately short and long. *A. longiferiens* sp. n. has an exceptionally long proboscis which is terminated by a crown of ten large obtuse teeth, separated from one another by three small pointed teeth. *A. ornatus*, *A. pictus*, and *A. macroph-*

thalma follow. *A. ehbiensis* sp. n. has a delicate body, and the proboscis is armed with thirty small equal teeth; it has been observed to reproduce itself either by a single male or female stolon, or by a chain of stolones. *A. punctatus* sp. n. differs from the last by having a double transverse row of small glands on each segment, and by the armature of its proboscis, which consists of twenty-four unequal teeth irregularly arranged; *A. lugens* and *A. edwarsi* are new species. *A. inermis* sp. n. is distinguished by the absence of teeth from its proboscis, while *A. megodon* sp. n. has a small number of well-developed teeth. A few words are said about *A. prolifer*. *Myrianida maculata* is fully described.

When one of the Syllidæ projects his proboscis the fleshy papillæ which precede it project from the mouth, and serve at first as a tactile organ; they then enlarge either to embrace a larger space, or to form a sucker, and then the arm which terminates the proboscis is darted rapidly once or twice, as the armed Nemerteans use their stylet. The author has often found adult examples without proboscis, proventriculus, or stomach; in place of these organs there was a duct like that which is found in sexual stolons, and the moniliform intestine commences at its usual spot. The cause of this irregularity remains for investigation. When the anterior part of the body is redeveloped the head and the regenerated segments are at first small and of the normal form, but the digestive canal is still a simple duct without proboscis or proventriculus; this was observed, for example, in *Syllis alternosetosa*, and *Odontosyllis fulgurans*.

In Syllids with direct reproduction the eyes increase very sensibly in size at the time when the sexual elements commence to ripen, and the natatory setæ to appear, just as in Nereids when about to take on the epitokous form. It would seem as if in those animals whose existence is specially precious there is a development of the organs which aid them in perceiving and escaping from danger; of the six eyes the two anterior appear to be rather pigment spots than optic organs.

A curious change of the muscular system obtains in the regions in which the natatory setæ are developed; the fibres increase in size and appear to become striated; a similar phenomenon obtains in the region of the remigerous setæ in Heteronereids. The canal of the teeth is very evident in *Pionosyllis longocirrata*, where it incloses a mass of small glands which are in communication with it and which seem to be poison-glands. Some Syllids have been observed (like a *Hesione*) to swallow water and even air. In *S. alternosetosa* it is effected in the following manner; the proboscis projects beyond the mouth, the proventriculus is distended transversely, and opening half-way along its median longitudinal line there is seen a delicate membrane, formed of circular muscles, which serves as an aspirator by causing a vacuum; the stomach is distended like the proventriculus, and the air and the water pass directly into the intestine; the two lateral gastric pouches appear to have the duty of containing the water; when they are closed their walls are distended and puffed out, and the vibratile cilia of their internal epithelium move very actively.

Organization of Chloræmidæ.*—M. J. Joyeux-Laffuie finds ten to fifteen specimens of *Chloræma dujardini* among the spines of a single example of the sea-urchin, *Toxopneustes lividus*. With regard to the numerous club-shaped prolongations, which have been hitherto regarded as parasites, they are probably, as Kölliker has suggested, tactile organs. The two tentacles in the cephalic infundibulum have internally a cavity which is divided into two by a delicate partition; with this branchiæform arrangement it is

* Comptes Rendus, civ. (1887) pp. 1377-9.

necessary to note that there is no blood-plexus, so that they are probably only accessory organs of respiration. The eye is not, as has been thought, formed by the union of two, but of four simple eyes arranged in cruciform fashion. Though the sexes are separated the gonads are similar in position and are best developed in spring and summer; at the reproductive period they attain a considerable size; the five pairs form elongated ovoid masses which float in the coelom, and are merely held in place by a vessel which arises from the ventral trunk; the ovaries are of a greenish brown and the testicles of a light rosy colour. As the integument is thin enough for the gonads to be seen through it, it is easy to determine the sex of a living specimen.

Nephridia of *Lanice conchilega*.*—Mr. J. T. Cunningham gives an account of the nephridia of *Lanice conchilega* Malmgren, which, owing to their coalescence, present a condition which approximates to that of the excretory system of vertebrates. On dissection, four long double nephridial tubes are seen projecting dorsalwards, and examination shows that these tubes belong to somites 6–9. The lower parts of the efferent tubes are very wide, and cannot be separated from one another. In somites 10–13 there are membranous nephridial sacs, which, externally at least, are inseparable from one another; these sacs are simple, and appear to be devoid of a nephrostome. When a number of horizontal longitudinal sections were made, it was seen that the lower parts of the efferent limbs of the four anterior normal nephridia, and the whole of the succeeding nephridial sacs are in open connection, so that a wide continuous longitudinal tube extends from the sixth to the thirteenth somite. This is the first case in which communication between successive nephridia has ever been discovered in any adult invertebrate, and, though the presence of a metameric series of nephrostomata in vertebrate embryos has long been seen to constitute a resemblance between them and the Chætopoda, no Chætopod was known to resemble a vertebrate by having a number of nephridia coalesced to form a continuous longitudinal tube.

***Criodrilus lacuum*.**—Dr. L. Oerley† gives an account of his morphological and biological observations on this incompletely known terricolous Oligochaete. It is a mud-worm 4–12 cm. in length, dark-brown or greenish dorsally, the body is quadrangular, and ends in a pointed yellowish, and often regenerated tail. There are from 200–250 or more somites; the four rows of setæ extend along the corners of the body; the genital organs are on the plan of *Lumbricus*, and present no peculiarities; the spermatophores are hornlike, and vary in number; each consists of a homogeneous, hyaline, mucous substance, in which a number of fine elongated filaments are imbedded. The bundles of spermatozoa are massed together in a spiral fashion. Nothing positive is known as to the time of sexual maturity, but Dr. Oerley is inclined to place it from March to the end of May. In no case did he find any trace of a clitellum, or of the so-called tubercula pubertatis; the male genital pore has a great glandular areola, and this appears to replace the clitellum. The cocoons are spindle-shaped, parchment-like structures about 5 cm. long; they change in colour in a way which reminds the author of the egg-cases of shark embryos, and, as in these, it seems to be due to chemical changes. The structure of the cocoon is described in detail. *Criodrilus* is to be found when the bottom of rivers is very nitrogenous, owing to the decomposition of organic matter; *Sum latifolium* appears to be its favourite plant. In the economy of nature

* Nature, xxxvi. (1887) pp. 162–3.

† Quart. Journ. Micr. Sci., xxvii. (1887) pp. 551–60 (8 figs.).

they seem to do good service by their destruction of organic matter, while their fæces increase the goodness of the mud. Their power of regeneration is very remarkable.

Mr. W. B. Benham* has made this worm the subject of the third of his "Studies on Earthworms." The epidermis has but few mucous cells, and between its cells there pass blood-vessels as in the leech, *Perionyx*, and *Perichæta*. A considerable difference in appearance was detected behind somite XV. and extends to about somite XLVII., and the epidermis is there changed in character; in addition to the columnar cells of the general surface, there is a layer of elongated club-shaped cells, which have a very similar appearance to those in the clitellum of *Lumbricus* and *Microchæta*; another point of difference from *Lumbricus* is the absence of strands of connective tissue separating the club-shaped cells into more or less distinct groups. This clitellar structure appears to have been overlooked from its commencing and ending gradually, and from there being no difference of colour in the living worm. The nephridia-pores were not detected. From all other earthworms save *Pontodrilus*, *Criodrilus* differs in the absence of a gizzard; there is a moderate-sized typhlosole, contrary to the statement of Vejdovsky. The nephridia are not present in front of somite XIII.; in and behind it they are large organs, with a slight muscular vesicular portion. The seminal reservoirs are constructed on the plan of *Allolobophora*; the testes have a digitate form, and from their deep position are very difficult to find at first. The ovary is a flattened rounded disc, and the receptaculum ovarum, or, as Mr. Benham prefers to call it, the ovisac, is a botryoidal protrusion of the posterior septum of somite XIII. The author thinks that Dr. Oerley is mistaken as to the spermathecae, as he was unable to find any trace of them, and it is suggested that the ciliated rosettes were mistaken for them. The worm should be looked for in this country.

Sig. D. Rosa sums up† the principal facts observed in his researches on *Criodrilus lacuum*, especially those relating to the genital organs, of which he enumerates the parts and indicates the position relative to the segments.

From his researches the author arrives at the following conclusion: "*Criodrilus* has its nearest relations in the *Allolobophora* (*A. turgida* Eisen, &c.); it belongs to the same *phylum* of the true *Lumbricidæ*, of which it is an extremely modified form."

He proposes to create a sub-family *Criodrilinæ* of the family *Lumbricidæ*.

Anatomy of Priapulidæ.‡—Dr. H. Schauinsland has continued§ his studies on *Halicyptus* and *Priapulius*. The central nervous system lies altogether in the ectodermal epithelium. Although it is not in any way distinctly segmented, yet there are indications of segmentation. In the regular interspaces which lie between the separate bundles of circular muscles, there is a greater aggregation of ganglionic cells than in the rest of the course. Just in front of the division of the œsophageal ring there are three ganglionic masses, which correspond to the subœsophageal ganglion of Annelids. Peripheral nerves are given off from the sides of the nerve-cord along its whole course, a larger number being, of course, given off from the ganglionic swellings than from elsewhere. This intensifies the impression of a commencing metamerism of the nervous system. The peripheral nerves never form a completely closed ring, as they are said to do in *Sipunculus*,

* Tom. cit., pp. 561-72 (11 figs.).

† Boll. Mus. Zool. e Anat. Comp. R. Univ. Torino, i. (1886) pt. 15.

‡ Zool. Anzeig., x. (1887) pp. 171-3.

§ See this Journal, ante, p. 91.

but soon break up into fine nerve-fibres, which course in various directions, forming at last a plexus of the finest nerve-fibrils. The whole arrangement of this terminal nerve-plexus agrees in almost every detail with the epidermal plexus of the peripheral nervous system of *Sagitta*.

The plexus is especially thick in the region of those peculiar dermal structures which so richly cover the body of *Halieryptus*, and these, therefore, may be definitely regarded as tactile organs. True unicellular glands are found abundantly among the epidermal cells, just as in *Oligochaeta*. The intestine has a longitudinal and a circular layer of muscles, while just beneath the epithelium there is a layer of very fine muscular fibres, which extend in all directions. They agree in structure with those of the body in forming a tube which is filled with protoplasm, and has walls formed by fine fibrils. The enteric epithelial cells are extraordinarily long, and have at their upper ends a knob-like swelling, with a fringe of very short and fine cilia. The whole wall is traversed in all directions by a system of very fine canaliculi, which have, perhaps, the function of chyle-vessels. Among the celomic corpuscles some are small and lively amœboid, and others larger and non-amœboid. They appear to be derived from the numerous amœboid connective-tissue cells, which are not only able to move about among the tissues, but to pass into the cœlom. Between these and the small forms there are various intermediate stages. It may be remembered that Kükenthal found the same mode of origin for the lymphoid cells of Annelids.

B. Nemathelminthes.

Process of Fertilization in *Ascaris megalcephala*.*—Dr. O. Zacharias has made use of some new methods of investigation for the purpose of studying the finer processes in the fertilization of the egg of *Ascaris megalcephala*, as he suspected that Nussbaum and van Beneden had had to do with injured ova. By this new method, in which he successfully hardens the ova in two hours, and preserves them without any shrinking of the yolk, he has been able to obtain a series of the intermediate stages in the formation of the pronucleus which were as yet wanting. The results agree with the theory of O. Hertwig as to the fusion of the genital products, and give a fresh support to it. What Prof. E. van Beneden took for pronuclei are reported to be already conjugated nuclei. A full account of the results is promised.

Revision of the Gordiidae.†—M. A. Villot discusses and describes nine of the species of the genus *Gordius*. Four of these—*G. affinis*, *G. alpestris*, *G. gemmatus*, and *G. Bouvieri*—are new. The last named is alone an exotic form; all the rest were collected in the neighbourhood of Grenoble.

The author expresses his dissatisfaction with most of the descriptions of preceding authors. The variations in length and breadth are so great that these characters must not be supposed to have any specific value. The coloration of the integument depends on the extent to which chitinization has proceeded; in all species young individuals are of a uniform milk-white colour, and the females are always less deeply coloured than the males, and after the deposition of ova their integument has almost always the transparency of glass. The possession of a buccal orifice, and the division of the body into rings are youthful characters, of which no traces are left in old individuals. The form of the two extremities is really of specific importance, but even here attention must be given to the age of the specimens. The bifidity of the caudal extremity of the males is a sexual character, and

* Zool. Anzeig., x. (1887) pp. 164-6.

† Ann. Sci. Nat., i. (1887) pp. 271-318 (3 pls.).

is probably of generic importance. The microscopic study of the peculiarities of the cuticle is, as the author showed in 1873, a very important aid to the discrimination of the species, and this has been recognized by later writers, and especially by Oerley; the author points out the care which is to be taken in making use of this method of investigation.

Under *Gordius aquaticus* the names of eight other "species" are included. Its variability may be judged of from this fact alone. This species is very fully dealt with in a useful and exhaustive manner. Of *G. alpestris* the author has only as yet been able to obtain male specimens. In *G. tolosanus* the epidermis presents both specific and sexual characters, for in the males the large hemispherical areolæ have a large pore at their summit. This species has been once found in the human intestine. The species is most often found free at the end of the month of June. *G. affinis* is based on a single female specimen, but its cuticular characters are sufficient to distinguish it. Some additions and corrections are made to Baird's description of *G. pustulosus*. *G. gemmatus* is the sole representative of a distinct group of the genus. *G. violaceus* has probably often been confounded with *G. aquaticus*. It is an error to suppose that the trilobate character of the hinder extremity of *G. gratianopolensis* is a good specific mark of distinction. *G. bouvieri*, from an unknown locality, is distinguished from the indigenous forms by its large size.

Filaria inermis.*—Prof. B. Grassi gives a description of a new species of *Filaria* which has been found in man, the horse, and the ass. The female, which alone is known, is about 16 cm. long, and appears to be much broader (475 μ) than thick. The specific name of *inermis* is due to the absence of teeth. The first example was found in a woman in the province of Catania, and was sexually immature. A specimen was found in the eye of the ass. Other examples were found in the eye of a man, and in horses (organ?), in Mailand. According to the system of Molin, this new species falls into the section Acheilostomi, and appears to be allied to *Filaria perforans*, which differs from it by having the posterior extremity "valde attenuata." The author thinks that the *F. peritonæi hominis* of Babes is identical with his species.

Muscular Fibres of Echinorhynchus.†—In regard to the disputed import of the longitudinal lateral bands projecting internally on the wall of *Echinorhynchus gigas*, M. R. Kœhler corroborates the observations of Schneider, and maintains that they are sack-like expansions of the circular fibres. The relations of the muscle-fibres in *E. heruca* are of importance in this connection, and are described. The two longitudinal bands are not homologous with the lateral bands of *E. gigas*, but arise from the enlargement of the cells in which the longitudinal fibres are developed. In regard to the large number of nuclei found in the muscle-cells of most *Echinorhynchi*, but in small proportion in *E. gigas*, M. Kœhler suggests that each fibre corresponds to a cell, and that the muscle-nuclei are conserved in the bands, while they have disappeared in other regions of the body.

Morphology of Muscular Fibres in Echinorhynchus.‡—M. R. Kœhler, in a subsequent paper, describes the muscular fibre in *Echinorhynchus heruca*, *E. proteus*, and *E. gigas*. In the first of the three species the large muscle-cells of the circular layer each consists of an internal unmodified portion of protoplasm, with a nucleus, and an external contractile portion containing a large number of fibrils. In the longitudinal layer the fibrils

* Centralbl. f. Bacteriol. u. Parasitenkunde, i. (1887) pp. 617-23.

† Comptes Rendus, civ. (1887) pp. 1192-4.

‡ Ibid., pp. 1634-6.

form three or four groups in each cell, each group constituting a tubular fibre. In *E. proteus* each muscle-cell incloses a much larger number of groups of fibrils, imbedded in unmodified protoplasm; the cells are larger than in the previous species, and there are fewer of them. In *E. gigas* the cells are enormous, and each incloses an infinite number of groups of fibrils, forming complicated fibres, surrounded by unmodified protoplasm.

The transverse muscle-cells of *E. heruca* have the value of primitive bundles, those of *E. proteus* have a lower morphological value, though still portions of primitive bundles, and this value is still less in *E. gigas*.

He draws attention to similarity between the muscle-cells of *Ascaris* and those of *E. heruca*, but considers that the two groups are not closely related.

γ. Platyhelminthes.

Stichocotyle nephropis.*—Mr. J. T. Cunningham describes a new form of Trematode found parasitic in the intestine of the Norway lobster—*Nephrops norvegicus*; there is as yet no evidence as to how the fluke reaches the intestine of the lobster; in it they are found encysted; the other host is probably some large fish which feeds on *Nephrops*. It is a typical Trematode, remarkable, however, for the arrangement of the suckers, which is entirely novel; they form a single series extending along the median ventral line throughout nearly the whole length of the body, and, unlike forms to which it may be allied, the suckers are not provided with chitinous hooks. *Stichocotyle* may be placed with the Polystomidæ, though it differs from all known forms in passing through an encysted stage within the body of another animal. The cyst appears to be a pathological product of the tissue of the intestine of the host. The worms are from 0.75 to 8.6 mm. in length, white in colour, and somewhat opaque; the mouth is small, simple, and circular; the suckers present some of the characters of metamerism. The presence of closely-set transverse folds gives the body a crenated figure; these folds disappear when the body is much extended, and are probably due to the presence of an inelastic cuticle.

New Trematode.†—Dr. J. Brock describes a new genus of Trematode—*Euryceelum shuteri*—which he found abundantly in the stomach of a Percoid—*Diacope metallicus*. The body has an elongated cylindrical form, slightly pointed anteriorly and posteriorly, with a small oral, and much larger approximately median sucker. The germinal glands are not always, but only temporarily connected with the efferent ducts. The connection of testes and vesicula seminalis is notably transitional. The yolk-glands are elongated sacs, occupying an asymmetrical dorsal position. They are not connected with the oviduct or shell-gland till the period of female maturity. Nor does the uterus acquire an external aperture till a late stage. There is no common generative atrium. Although the uterus remains blind during most of the female maturity, and there is no communication with the male organs, both its proximal portion and the oviduct contain very early abundant sperms which fertilize the ova. The possibility of self-fertilization or of cross-fertilization is obviously excluded. The third alternative remains of a communication via Laurer's canal. This was not, however, demonstrated. The longitudinal stems of the excretory system are so wide that they must be called spaces rather than canals, and look like the beginning of a body-cavity.

Ciliated Pits of Stenostoma.‡—Herr B. Landsberg has found the pyriform ganglia discovered by Vejdosky at the base of the ciliated pits of

* Trans. Roy. Soc. Edinb., xxxii. (n.d.) pp. 273-80 (1 pl.).

† Göttingen Nachrichten, 1886, pp. 543-7. ‡ Zool. Anzeig., x. (1887) pp. 169-71.

some species of *Stenostoma*. To examine them in section cuts must be taken in an oblique direction through *S. leucops*. The base of the pits is covered by a pretty thick layer of uncoloured homogeneous substance, which may be regarded as mucus; below this is a thin layer of ciliated epithelial cells, and there then follows a thicker layer, which consists largely of pyriform cells, but also of other histological elements; only one nerve reaches close to the pits, where it divides and gives off a branch to each little pit; this is shown to be sensory by its investment with very small ganglion-cells. Teasing revealed the presence of bi-polar and some multipolar ganglion cells, the processes of which form plexuses, ciliated epithelial cells of various sizes, partly membranous cells which have an investing function, goblet-like mucous cells, muscular fibres which cut the plexuses at right angles, and special cells, which may perhaps be regarded as sensory; these last are rounded or oval, have a distinct nucleus and nucleolus, and are on one side drawn out into a pencil-like process, and on the other continued into a fine fibre.

Distoma endemicum.*—Prof. I. Ijima has found that the form first described in 1883 by Prof. Baelz as *Distoma hepatis endemicum* is found not only in man but also in cats in Japan. The latter fact makes it easier to trace the history of the fluke, but the author has not yet been able to determine what inhabitant of the ditch-water it is into which the ciliated embryos pass for an intermediate host. He doubts whether Baelz is right in supposing that the parasites return to man in ditch-water, and suggests that more worthy objects of suspicion are (1) *Paludina* and *Corbicula*, though these are never eaten in a raw condition, (2) vegetables which have been washed with ditch-water, or (3) a second intermediate host, such as shrimps or various fishes.

The parasite, when fresh, is translucent; the body is about 11·75 mm. long, and its greatest breadth is from 2–2·75 mm., so that it is not unlike *D. lanceolatum* in shape; the "brain" forms a bridge over the œsophagus, and does not lie, as is usual, above or in front of the pharynx. What has hitherto been taken for the ovary is a contracted mass of spermatozoa. The ova are unusually small, and the embryos are of an elongated oval shape, 0·025 mm. long; there are no eye-spots.

Land Planarians.†—Dr. D. Bergendal has a preliminary notice of his investigations on *Bipalium kewense* which has been found in the orchid-houses of the Botanic Garden at Berlin. Referring to the question of multiplication by transverse division, as to which it will be remembered Prof. Bell made some observations to the Society last year,‡ the author states that he has never been able to find sexually mature specimens, though in one case sections showed small aggregations of cells which might be regarded as rudiments of testes. Spontaneous transverse division was three times observed in forms from which pretty large pieces had been cut off at the anterior end; the large quantity of small pieces which were found in the hot-houses are, of themselves, sufficient to show that the phenomenon is not very rare.

The excretory vascular apparatus consists of a ciliated funnel with a very strong "flame," irregular or plexiform canals, and longitudinal trunks. The last undulate slightly, and two or more are found dorsally and laterally to the enteric branches; there are also ventral longitudinal trunks. All consist of large cells, and have thick cilia, the papilliform basal portions of which give a plexiform appearance to the walls. From these long trunks

* Journ. College of Science Imp. Univ. Japan, i. (1886) pp. 47–59 (1 pl.).

† Zool. Anzeig., x. (1887) pp. 218–24.

‡ This Journal, 1886, p. 1007.

transverse straight canals are given off, which may partly serve as efferent, and partly as collecting canals. The long canals lie so deeply in the parenchyma, that it is hardly possible to observe them except in sections. The plexiform canals and the ciliated funnels must, however, be studied in living tissue; the latter are connected with the former by canals of varying length in which there seem to be no cilia.

The nerve-trunks vary in structure in different parts; the longitudinal trunks are connected by transverse commissures which are very thin, and often branch; the author was also able to detect these commissures in specimens of *Bipalium Diana*. In addition to these there are strongly arched nerves, which form a plexus under the skin, which is best developed on the head and in the anterior part of the body; the ganglionic cells are large, and have very large nuclei, with two or three processes. The longitudinal nerves are connected with one another at the hinder end of the body. In the cephalic region there is a flattened brain, the formation of which is clearly due to the union and increase in size of the longitudinal trunks; from this region strong nerve-branches pass to the pits found at the anterior end; the nerve-fibrils are thick, and give off from their ends fine prolongations which extend outwards between the cells of the epidermis. Eyes are present in large numbers, and form a zone three or four rows deep at the margin of the head; they are also found at the sides of the body as far as its posterior end. The largest eyes lie just behind the head. In structure they agree closely with those of the other Tricladæ, and they are supplied with nerves from the superficial plexus; in some cases a ganglion-like swelling was noticed at the sides or in front of the eyes.

The whole body is provided with cilia; between the ordinary epithelial cells there are here and there groups of more delicate, rod-like cells, which may possibly be sensory organs; the rhabdites are mostly small and spindle-shaped, but not a few are filamentary and more or less rolled on themselves; both kinds are found in the same cell.

In *B. Diana* an encysted Nematode was observed, and in the unpaired exterior branch there was a gastropod radula. Fuller accounts with illustrative figures are promised.

Function of Uterus or Enigmatic Organ in Fresh-water Dendrocœla.*
M. P. Hallez appears to agree with Ijima in thinking that the function of the so-called uterus of fresh-water dendrocœle planarians is that of a gland which secretes the substance that forms the envelope of the cocoon. The organ called enigmatic by O. Schmidt, and muscular glandular organ by Ijima, appears to M. Hallez to act as a pump or piston which drives into the cloaca the male elements; and it is not impossible that it also serves to distribute the fertilized ova, and to expel the cocoon. *Planaria polychroa*, which is without this organ, has muscular fibres in the cloaca and near the orifice of the uterine canal; these appear to take the place of the absent organ.

In the rhabdocœlous planarians, and especially in *Vortex*, there is an organ which appears to be similar to the enigmatic organ; it is known as the bursa copulatrix, and the same name might well be applied to the organ in the Planariæ.

δ. Incertæ Sedis.

Balanoglossus Larva.†—Mr. W. F. R. Weldon describes a larva, not unlike that described recently by Mr. Bateson, which has, however, a very different history. After the development of the gill-slits there appears to be

* Comptes Rendus, civ. (1887) pp. 1529-32.

† Proc. Roy. Soc. Lond., xlii. (1887) pp. 146-50.

much variation in the conduct of the larvæ; some exhibit indications of a normal development, but the majority undergo a gradual process of degeneration, accompanied by considerable increase in size; the proboscis cavity becomes smaller, its wall thinner, and its muscles fewer; the notochord, collar cavities, and gill-pouches disappear; the ectoderm becomes much thinner, and the greater part of the nervous system disappears. This larva was observed at Bemini, Bahamas. A little later, a much larger larva, found at Nassau, New Providence, was found to undergo still further degradation, the ectoderm over the greater part of the body becoming a mere flattened epithelium, the trunk cavity a minute solid rod, and the proboscis cavity much further reduced than in the Bemini larva.

The cause of this degradation is probably the compulsory shifting of the larvæ into deep water; if this be admitted it follows that, in some cases at least, the transmission by a larva of hereditary changes is only possible on the application of certain stimuli, that where these are wanting, some larvæ are highly variable, that the variations due to change in environment may be uniform and definite, and that the changes may result in the hypertrophy of the larval organs.

Trichodina paradoxa.*—Prof. H. Ludwig has a note on the remarkable parasite of the *Firoidæ*, lately described by M. Barrois,† showing that it is nothing more than the separate capitulum of a gemmæform pedicellaria, and almost certainly of *Sphærechinus granularis*.

Echinodermata.

Mergui Ophiurids.‡—Prof. P. Martin Duncan has a report on the thirteen species of Ophiurids collected by Dr. J. Anderson in the Mergui Archipelago; of these nine are new and one is the representative of a new genus—*Ophiocampsis*, which is placed near *Ophiothrix*; this form is able to bend its arm in a vertical downward plane and has no upper arm-plates. In a succeeding contribution,§ the author deals with some points in the anatomy of *Ophiothrix variabilis*, and *Ophiocampsis pellicula*; as to the latter, the opposed surfaces of the arm-bones are remarkable, particularly because of the enormous upper muscle-area on the aboral surface of the arm-bones, and the “peg” is absent; there are no knobs on the adoral surface, while the large size of the slot and the obliquity of the apophysis allowed of great downward bending as well as of lateral movement. Especial attention is given to the arrangement of muscles in *Ophiothrix*, and it is clear that the development and distribution of muscles is not the same among all Ophiuridæ. With regard to the subsequent term “chewing apparatus,” the author points out that the arrangement of the jaws does not admit of chewing, though the process of filtering occurs.

Cœlenterata.

Chromatology of Anthea cereus.||—Dr. C. A. MacMunn has found chlorophyll as well as chlorofucin in extracts of the “yellow cells.” If sections of the tentacles are made after hardening in alcohol the mass of yellow cells are found packed in the tentacle at random as it were, and it seemed to be quite clear that these bodies are not secreting cells. The chlorophyll of *Anthea* differs from other chlorophylls in its remarkable instability towards caustic alkalies, and the chlorofucin which accompanies

* Zool. Anzeig., x. (1887) pp. 296-8.

† Journ. Linn. Soc. Lond., xxi. (1887) pp. 85-106.

|| Quart. Journ. Micr. Sci., xxvii. (1887) pp. 573-90.

‡ See this Journal, ante, p. 373.

§ Ibid., pp. 107-20 (4 pls.).

it is also remarkably unstable. Precisely the same colouring matters are present in the tentacles as in the rest of the animal, and as those in the tentacles are due to yellow cells it is fair to conclude that those of the latter have the same origin, and do not belong intrinsically to the animal. The author cannot accept Krukenberg's view that the colouring matters of *Anthea* are allied to "hepatochromates," because enterochlorophyll is not nearly so easily decomposed as are the pigments of *Anthea*, and they are at once distinguished by Stokes's fractional method.

North Sea Alcyonida.*—Dr. D. Danielssen finds that the Alcyonids collected by the Norwegian North Sea Expedition of 1876–8 are exclusively deep-sea forms; nine new genera belong to the Alcyonidæ, in addition to which there are two new species of *Clavularia*, one of *Symphodium*, one of *Nidalia*, and a new genus and species representative of a new sub-family—that of the Organinæ. With regard to the anatomical and histological details, the most important appear to be:—the discovery in *Væringia mirabilis* of a group of large ganglion cells on the uppermost part of the ventral surface of the gullet; these have a prolongation rich in protoplasm, and under them there are smaller, round, pellucid cells and extremely slender fibrils; unfortunately, the condition of the specimens did not permit of these interesting indications being more completely investigated. In all the species examined the œsophagus had, on its inner ventral surface, a groove coated with long flagelliform cells; in *Gersemiopsis arctica* g. et sp. n., the channel is divided longitudinally so that the gullet groove forms the true œsophagus, and the remaining part may be regarded as an intestine. The œsophagus is richly supplied with unicellular mucous glands, which were also found in great abundance on the outer surface of the polyps of all the species examined. It does not appear that there is no division of labour in the colonies of Alcyonids, for in *Nephthys* several species were found to have special reproductive polyps; and as soon as the elements are matured the tentacles become curved in towards the oral aperture, which becomes closed by a viscid mucous; the gullet-tube becomes converted into a uterus, in which development proceeds, and during this period such polyps are nourished by others of the colony.

Of the new genus *Væringia* there are nine new species; of *Duva* eight; of *Drifa* two; of *Nannodendron* one; of *Fulla* one; of *Gersemiopsis* one; of *Barathobius* one; of *Sarakka* one, and of *Krystallofarces* one. The new sub-section Organinæ has the zoanthodem poor in sarcosoma, the polyp-cells are long and so arranged as to give to the whole structure somewhat of the appearance of a collection of organ-pipes; the new genus *Organidus* has its single species dedicated to Baron von Nordenskjöld. The plates are as beautiful as in preceding memoirs of this series.

Porifera.

Systematic Position and Classification of Sponges.†—Dr. R. von Lendenfeld makes use of the nomenclature of the spicules recently established by Messrs. Sollas, Ridley, and Dendy, but it is incomplete in so far as the proposals of Prof. Sollas have been only partly published as yet.

With regard to the systematic position of the Sponges, the view that they ought not to be included among the Metazoa is rejected; they are Cœlentera in the sense that the Cœlentera and Cœlomata make up the Metazoa; from what are ordinarily called Cœlenterata (Nematophora or

* Den Norske Nordhavs Expedition, 1876–8, xvii. Alcyonida. 4to, Christiania, 1887, v. and 169 pp., 23 pls., 1 map.

† Proc. Zool. Soc. Lond., 1886 (1887) pp. 558–662.

Cnidaria) they are sharply distinguished; while the Cœlenterates may be called Epithelaria, the Sponges are Mesodermalia; the latter may have, the former never have, a branching canal system. With regard to their tissues, the Mesodermalia have invariably simple ectodermal and endodermal epithelia, the cells of which are always flat pavement-cells, and are never converted into muscular, glandular, sexual, or sensitive elements; such elements are in Sponges invariably modified cells of the mesogloea; the Epithelaria, on the other hand, have a mesogloea, the cells of which remain more or less amoeboid, and are not differentiated to any extent. The muscular, glandular, sexual, and sensitive cells are produced in the epithelia, sinking below the outer cell-layer with advancing development, and lying on the surface of the mesogloea or supporting lamella. A phylogenetic table and a systematic classification follow.

With regard to the classification of Sponges, Dr. v. Lendenfeld regards the composition of the skeleton as affording the first basis; those in which the skeleton is composed chiefly of carbonate of lime form the subclass Calcareae, and those in which it is originally composed of siliceous spicules are the Siliceae; in the former there is the single order of the Calcispongiæ, while the latter are divisible into (1) Hexactinellida, where the mesogloea is soft, and the supporting skeleton is often strengthened with siliceous cement; the spicules are triaxial; (2) Chondrospongiæ, where the mesogloea is hard, the toughness being due to the hardening of the ground-substance; the spicules are tetraxial, monaxial, anaxial, or absent: in (3) the Cornacuspongiæ, the mesogloea is soft, the supporting skeleton is strengthened by spongin cement or exclusively formed of spongin, with or without foreign bodies; spicules are monaxial or absent. A systematic table is followed by a key to the recent families of Sponges, and a compendious bibliography completes the paper.

Relationships of the Porifera.*—Dr. G. C. J. Vosmaer accepts Gray's division of the Sponges into Calcareae and Non-Calcareae; the latter class is divided into Hyalospongia (= *Hexactinellidæ* of authors), Spiculispongiæ, and Cornacuspongiæ; though we do not know of any direct transition from the first to the other two orders, yet there are certain indications among many already known facts, and the author states that he has found many sponges in which there are a few rudimentary six-rayed spicules lying among the normal ones.

The hypothesis that Sponges are Cœlenterates is not accepted; arguments against the degeneration-idea of Marshall are brought forward, and it is urged that the central cavity of sponges is in no way a gastric cavity; the argument from development is distinctly against the Cœlenterate affinity of sponges.

"If we accept a free-swimming form as the ancestor, and suppose further structures become secreted in certain cells (thereby conferring an advantage in rendering these delicate forms of life less subject to fall a prey to other animals), then we must at the same time believe that in one group calcareous, and in another siliceous matter was developed. But this new development led to the restriction, nay, finally, even to the complete prevention of free movement, and thereby a higher animal development was precluded. Sessile animals must develop in a special direction in order to maintain the struggle for existence. Nutrition and respiration must be assured; hence, though the degree of development is a low one, yet a well-developed canal-system has been formed."

* Vosmaer, 'Porifera' in Bronn's Klassen u. Ordnungen, ii. pp. 472-81. See Ann. and Mag. Nat. Hist., xix. (1887) pp. 249-60.

Dr. Vosmaer believes that the oldest sponges were deep-sea forms, and that a consequence of their living in shallow regions has been an arrest of development, the skeleton degenerating and the variety of spicular forms being gradually reduced.

The most primitive forms of the Calcarea were, possibly, Olynthus-like; these gave rise to the Asconidæ and the ancestors of the Syconidæ, as well as to the Leuconidæ and Teichonidæ. The primitive form also gave rise to the Siliceous Sponges with triaxonid spicules; thence the Hyalospongiæ and the Tetraxonina. The hyalospongine stock gave rise to the Lithistina, Geodidæ, and Ancorinidæ; from the last arose the Plakinidæ and Corticidæ, and doubtless also the Chondrosidæ and Halisarcæ; the main stem degenerated and gave rise to the Halichondridæ; the appearance of spongin rendered spicules superfluous, and thus appeared progressively the Spongidæ, Aplysinidæ, and Darwinellidæ.

Reproductive Elements of Spongia.*—Mr. H. J. Carter has an essay on the reproductive elements of sponges, in which he gives some information as to the structure and position of the ovum in *Chondrosia spurca*, and the history of some of the discoveries connected with this subject.

Protozoa.

Biology of *Astasia ocellata* and *Euglena viridis*.†—M. W. Khawkiné finds that *Astasia ocellata* sp. n. and *Euglena viridis* resemble one another in each being a naked cell of almost the same form and size, whose body is composed of ectoplasm and endoplasm. The former is a closed sac of elongated form (fusiform, or acutely or conically cylindrical), with a small orifice at its anterior end which leads into a pharynx; one flagelliform filament is attached to one of the walls of this canal. This sac is impregnated to a certain extent with elements which do not undergo putrefaction, and according to the forms of contraction, we may attribute to it a muscular structure, the fibrils being disposed in a manner suitable to independent contraction. The form and disposition of these fibrils are not the same in the two organisms; in *Euglena viridis* they are longitudinal and annular, and the latter are only found in the anterior part of the body; *Astasia ocellata* has annular fibrils only, and they extend from one end of the body to the other. The endoplasm of *Astasia* is characterized by the thickness of its consistency and by its immobility, and this appears to be the cause of the diversity of its form in various stages of development; in *Euglena*, the endoplasm is less compact, and changes its place more easily; but in this point various species of *Euglena* differ. In both forms there is a nucleus, nucleolus, and accessory elements; the last, in *Astasia*, being limited to small granules, which appear to be the organs that elaborate the grains of paramylon; *Euglena viridis* has none of these small granules, and the grains of paramylon depend either on the plasma (or chromatophores), which are situated at the centre of the body. Here, again, *Euglena* presents some variations, for in some the part in question is single, in others double, and in yet others the grains of paramylon appear notwithstanding its absence. Like all colourless protoplasm, that of *Euglena* and *Astasia* is easily able to appropriate to itself assimilable organic products; this process, as well as the contrary one of waste, obtains more largely in the endo- than the ectoplasm, and provokes, during abundant nutrition, an unstable equilibrium and a positive pressure between the contents and the surface. In periods of famine there is a "vegetative pressure" between

* Ann. and Mag. Nat. Hist., xix. (1887) pp. 350-60.

† Ann. Sci. Nat., i. (1887) pp. 319-76 (1 pl.).

the parts. In the former case, the result is that the organism divides into two; the process of division is effected in the same way in both forms.

As is well known, *Euglena* may be distinguished from *Astasia* by the possession of this chlorophyll, and to this we must ascribe the differences which are to be observed between the vital functions of these two organisms; these differences are—(1) that the chromatophores present the source of an abundant nutrition by means of inorganic elements, and (2) one of the products is a considerable quantity of mucus which exudes by the walls of the body.

Thanks to the first circumstance, *Euglena* appears to be accustomed to this kind of inorganic food to such an extent that deprivation is distinctly felt, though it is not fatal; in darkness, *Euglena*, unlike *Astasia*, does not seem to be able to undergo free division, but invests itself in a solid impermeable cyst. The second circumstance, the abundant secretion of mucus, leads, in ordinary division, to the immobile state, and the formation of complex groups; two facts which play an extremely important part in the life of the *Euglena*, and which are, if not the sole, yet the most important cause of the great difference in the numerical propagation of the two forms. *Astasia*, spending all its life in movement, has but little left wherewith to reproduce itself; *Euglena*, on the other hand, leads a quieter life. The mucous coverings of *Euglena* defend it from cold, heat, and evaporation, enemies, and the effects of an insufficient supply of food, while, when they form themselves into a connected mass, the ciliate Infusoria, which prey on them when they are single, are unable to attack them. *Astasia*, on the other hand, cannot form either colonial groups or united membranes, and so, in the struggle, has one important weapon the less.

As all these facts are due to the presence in one and the absence from the other of the chromatophores, these appear to be the sole essential character which distinguishes *Astasia* from *Euglena*; the one is an *Astasia* provided with chromatophores, the other a *Euglena* devoid of them; in fact, we may put our present knowledge thus:—If the Chitridiæ, which glide into the *Euglenæ* and first devour the chromatophores, were to leave without doing any other harm, there would be an organism identical with *Astasia* in all its essential characters and functions. Were this to happen, the *Euglena* would have to learn to be content with organic nutriment; indeed, the advantage in the struggle for existence that *Astasia* now has, is, that it can take assimilable organic nutriment which contains force-stuffs already made.

New Peridinian.*—M. J. Danysz describes the structure and life-history of a new Peridinian (*Gymnodinium muszei* n. sp.) found in the Jardin des Plantes. The flattened ellipsoidal form, the absence of cuticular envelope; the transverse groove dividing the body into two unequal parts, obliterated, however, at the middle on one side; and the presence of an irregular prominence at this point, bearing the superficial, red, ocular spot and the two flagella, are characteristic features.

The reproduction of *G. muszei* occurs (a) by means of successive divisions, (b) followed by the formation of spores—the result of the fusion of two individuals of minimum size. During July and August the development of an individual is complete in fifteen days, but in favourable conditions this may be much accelerated.

Peridinea.†—M. G. Pouchet communicates a fourth contribution to the history of the Peridinea. After a general introduction, in which he dis-

* Arch. Slav. Biol., iii. (1887) pp. 1-5.

† Journ. Anat. et Physiol., xxiii. (1887) pp. 87-112 (2 pls.).

cusses the history of research bearing upon these interesting forms, the author describes at length the genus *Gymnodinium*, with the species *G. helix* Pouchet, *G. polyphemus* var. *roseum*, *G. polyphemus* var. *nigrum*, *G. musæi*, Danysz, *G. punctatum* Pouchet; and further, *Polykrikos auricularia* Bergh. The latter inclosed in more than one instance a remarkable ovoid body, which presented all the appearances of an ovum.

Hæmatozoa of the Tortoise.*—Prof. B. Danilewsky communicates a further account of the minute parasites found in the blood-corpuscles (Hæmatozoa, Cytozoa, &c.). The present research gives an account of the form and structure of that found in the blood of *Emys lutaria*. The appearances of forms of various age and size, their influence on the blood-corpuscles, and other facts are discussed at length.

In a second paper,† the author describes the general biological characters of the parasite, its movements, relation to reagents, number, geographical distribution, and the like.

As regards its position among similar forms, the adult presents many close resemblances to *Drepanidium ranarum* and *avium*. The presence in the tortoise of gregarinid spores with falciform germs identical with the hæmocytozoa, suggests affinity with the Gregarinida. The size, simple constitution, single vesicular nucleus, characteristic movements and mode of life, all support this conclusion, but there can be little doubt that the form described really represents an adult. Danilewsky therefore refers it provisionally to the Monocystid Sporozoa, and names it *Hæmogregarina (Testudinis) Stepanowi*.

Protozoa as food of Sardines.‡—MM. G. Pouchet and J. de Guerne found an extraordinary abundance of Peridiniæ in the viscera of sardines from La Corogne; the species represented were *Peridinium divergens* and *P. polyedricum*. The latter literally fills the digestive tube, being recognizable even in the rectum; they measure on the average $36\ \mu$ in diameter; bringing *P. polyedricum* to the spherical form this gives the volume of an individual as about 25 mm. Estimating the capacity of the intestine at 1 cubic centimetre it equals the volume of forty millions of Peridiniæ; allowing for the intestines, this number may be reduced one-half, but twenty millions must be regarded as a minimum, for the Peridiniæ break up rapidly in the intestine of the fish.

New Infusoria from New Zealand.§—Mr. T. W. Kirk describes as new *Opercularia parallela*, which differs from *O. cylindrica* in being more cylindrical, and having no striæ. *Acineta simplex* n. sp. has a wineglass-shaped lorica, the anterior half of which is occupied by the animal; the tentacles are capitate, and are arranged in two groups of about ten each. Eleven species of *Vorticella* are identified with species described by Mr. Saville Kent in his Manual, and though the antipodean specimens differ slightly, the differences do not seem to be of specific value. *Vorticella oblonga* and *V. zealandica* are new species.

'Challenger' Radiolaria. ||—After ten years' work Prof. E. Hæckel has published his gigantic report on the Radiolaria collected by H.M.S. 'Challenger,' by himself and by various friends; the thousands of new species which have been discovered opens up a new field for morphological investigation; the total number of forms described in this report amounts

* Arch. Slav. Biol., iii. (1887) pp. 33-49 (2 pls.).

† Ibid., pp. 157-76.

‡ Comptes Rendus, civ. (1887) pp. 712-5. Cf. Ann. and Mag. Nat. Hist., xix. (1887) pp. 323-4.

§ Ann. and Mag. Nat. Hist., xix. (1887) pp. 439-41.

|| Reports of the Voyage of H.M.S. 'Challenger,' xl. (1887) 1803 pp., 140 pls.

to 4318 species, 3508 of which are new. For a really complete examination the lifetime of one man would not suffice.

The richest source of material was the Radiolarian ooze of the Pacific Ocean; the alimentary canal of aquatic animals, and the coprolites of the Jurassic period were full of specimens.

It will be useful to quote Prof. Häckel's definition of the Radiolaria:—"They are marine Rhizopoda, whose unicellular body always consists of two main portions, separated by a membrane; an inner central capsule (with one or more nuclei), and an extracapsulum (the external calymma, which has no nucleus and the pseudopodia); the endoplasm of the former and the exoplasm of the latter are connected by openings in the capsule membrane. The central capsule is partly the general central organ of the Radiolarian cell, partly the special organ of reproduction, since its intracapsular protoplasm, along with the nuclei imbedded in it, serves for the formation of flagellate spores. The extracapsulum is partly the general organ for intercourse with the outer world, partly the special organ of protection (calymma) and nutrition (sarcomatrix). The skeleton varies in form and is generally composed of silica, sometimes of acanthin. The cell usually leads an isolated existence (Monocyttaria), and only a small minority of one legion are united in colonies (Polycyttaria)."

The systematic catalogue is brought up to the year 1884, and contains 20 orders, 85 families, 739 genera, and 4318 species; this last is probably not one-half the number of recent species; two sub-classes may be established, the first, that of the Porulosa or Holotrypasta, containing the forms in which the central capsule is originally spherical, without osculum or principal opening with innumerable fine pores; the Osculosa or Mesotrypasta have the central capsule originally monaxid, with an osculum at the basal pole of the vertical main axis; each sub-class consists of two legions, first of the Spumellaria (Peripylea) and Acantharia (Actipylea), the second of the Nassellaria (Monopylea) and Phœodaria (Cannopylea). It is among the Spumellaria only that colonies are formed.

The characteristic capsule-membrane is not to be compared with an ordinary cell-membrane, but must be regarded as an internal differentiated product; the central capsule is regarded as the general central organ of the "cell-soul" for the discharge of its sensory and motor functions (comparable to a ganglion cell), and is also the special organ of reproduction (sporangium); it and the extracapsulum are to be regarded both morphologically and physiologically as the two characteristic co-ordinated principal parts of the unicellular Radiolarian organism. Sixteen geometrical types are recognized, and examples are given of each; the central capsule itself may belong to one of five well-marked different forms; the nuclei may be ellipsoidal, discoidal, stellate, amœboid or lobate. After describing the various secondary products which are also found within the capsule, the author passes to the extracapsulum which consists of the calymma or extracapsular jelly-veil, the sarcomatrix or layer of exoplasm immediately surrounding the membrane of the central capsule, the sarcodictyum or network of exoplasm, covering the surface of the calymma, and the pseudopodia or radial fibres of exoplasm, which are discussed separately and in detail.

In the fourth chapter the skeleton is elaborately dealt with; it is a part of the organism which is extremely well developed; in this chapter only the more important points are treated, the special differences being dealt with in the systematic portion of the monograph. In the ontogenetic development of the Radiolaria an *Astasia*-stage is succeeded by an *Actinophrys*-stage, that by *Sphæastrum*, and that by the *Actissa*-stage, *Actissa* being the prototype of the whole class.

The systematic disposition of this group is next considered, and is followed by the systematic description of its divisions, the whole work with its atlas of beautiful plates forming one of the most remarkable additions to zoological literature.

Psorosperms.*—Sig. A. Garbini finds that the granulations of the protoplasm and of the nucleus of Psorosperms found in the cæcum of the porpoise are not homogeneous, since by means of his double stain, some colour blue, others red. This difference only exists in the unincapsuled condition; at other times the granulations stain of one colour either all blue or all red. The author offers two explanations, either that before incapsulation the Psorosperm divides in such a way that all the blue-selecting granulations form one-half, and all the red-selecting the other half, or that during incapsulation the one set of granulations alter so as to become homogeneous with that of the other; in some cases becoming blue-selecting, in others red-selecting.



BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.†

(1) Cell-structure and Protoplasm.

Young Condition of Vacuoles.‡—Contrary to the generally accepted view, Herr F. A. F. C. Went has determined the presence of minute vacuoles even in the youngest cells, as, for instance, in the growing point. This was demonstrated by the application of a 10 per cent. solution of potassium nitrate, which kills the outer protoplasm and isolates the vesicles of cell-sap; they can then be burst by washing with water or by heat, and their fluid contents shown. The author found vacuoles also in oospheres, pollen-grains, and cambium-cells, and believes that they are present in all living cells, except possibly antherozoids, bacteria, and Cyanophyceæ.

Movements and changes take place at a very early period in these vacuoles, and the author believes that they always commence in the very youngest condition of cells, though they do not become readily obvious till a later period; these movements being always accompanied by changes in the form of the vacuole. Two frequently coalesce into a single vacuole, while others divide repeatedly by constriction through their middle. These processes are well seen in *Dematium pullulans*, in apical cells, meristem-cells, pollen-grains, and especially in young hairs; in young hairs of *Cucurbita Pepo* and in *Cladosporium herbarum* this division of a vacuole was seen to be followed by cell-division. All the vacuoles in a plant result, according to these observations, from the vacuoles of the oosphere, and these again from those of the mother-plant. Statements by previous observers of the fresh formation of vacuoles under certain circumstances he believes to be due to erroneous observation.

The author also calls attention to the occurrence in the same cell of vacuoles with different contents. In coloured cells it is not unfrequent to

* Acc. Agr. Art. Comm. Verona, lxiii. (1886).

† This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents; (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

‡ Arch. Néerland., xxi. (1887) pp. 283-315 (2 pls.).

find a large vacuole with coloured contents and a number of small ones with uncoloured cell-sap. This is the case, for example, in the petals of *Camellia japonica*. From this fact a conclusion is drawn favourable to the view that the wall of the vacuole takes an active part in the storing up of the substances dissolved in the cell-sap.

(2) Other Cell-contents.

Acidity of the Cell-sap.*—Dr. Lange has investigated the nature and proportion of the acid constituents of the cell-sap in a number of plants, both succulent and thin-leaved. He supports Warburg's statement † that the less refrangible rays of the spectrum are more efficacious in decomposing acids than the violet portion. Although dead plants contain a smaller proportion of acids than living plants, this is not, he states, due to the presence of carbonic acid in the living plant. The author confirms the observation of Kraus, of a periodical increase in the acidity of the sap in the morning and a corresponding decrease in the evening. As a general rule, chemical changes in the plant proceed much more energetically in the luminous or red than in the chemical or blue half of the spectrum. Tables are appended of the amount of acid found in the cell-sap of a number of plants at different periods of the day.

Chemistry of Chlorophyll.‡—Mr. E. Schunk, considering the intimate connection between chlorophyll and the carbon dioxide of the atmosphere, thought it might be interesting to ascertain whether compounds of phyllo-cyanin could be obtained in which the organic or other acid could be replaced by carbonic acid. On passing a current of carbonic acid for several hours through an alcoholic solution of phyllo-cyanin holding hydrated zinc oxide in suspension, and by further agencies, a compound is obtained which is a phyllo-cyanin zinc carbonate; this is decomposed by the action of strong acids, and yields phyllo-cyanin and carbonic acid. The author gives an account of the action of caustic alkali and zinc, and of hydrochloric acid and metallic tin on phyllo-cyanin.

Researches on Chlorophyll.§—Herr A. Tschirch gives a *résumé* of the most recent observations on the composition of chlorophyll, and confirms his previous view that iron is not a necessary constituent of the green colouring matter of leaves.

For phyllo-cyanic acid (Schunk's phyllo-cyanin) he gives the formula $C_{28}H_{47}N_3O_6$.

As regards the proportion in leaves of the substance to which the absorption of CO_2 is due, he finds in *Fuchsia ovata* that it constitutes from 2.55 to 4.71 per cent. of the dried substance freed from ash, and from 0.6081 to 1.0 g. per sq. m. of the surface of the leaf. In *Begonia manicata* the figures were 1.8 per cent. and 0.3808 g. per sq. m.; in *Plectogyne* sp. 1.92 per cent. and 1.2328 g. per sq. m.

Researches on Green and Yellow Chlorophyll.||—Dr. A. Hansen states that the orange-red pigment stated by several observers to have been found in leaves along with the yellow and red, is simply aggregations of the yellow chlorophyll-pigment, which has an orange tint when present in dense masses. He even obtained orange-red crystals.

* Ber. Naturf. Gesell. Halle, 1886, pp. 4-29. † See this Journal, 1886, p. 478.

‡ Proc. Roy. Soc. Lond., xlii. (1887) pp. 184-8 (1 pl.).

§ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 128-35. Cf. this Journal, 1886, p. 88.

|| Arbeit. Bot. Inst. Würzburg, iii. (1887) pp. 430-2.

Raphides in Typha.*—Dr. M. Kronfeld finds crystals of calcium oxalate in several species of *Typha*. They were found only in the male flowers, in the filament and connective, and especially in the endothecium or inner layer of the wall of the anther. In the female flowers they appear to be replaced by a yellow oily substance.

Calcium oxalate in the Cell-wall of Nyctagineæ.†—Herr A. Heimerl finds the presence or absence of a deposit of calcium oxalate in the cell-wall in different genera of this order to go along with other characters of taxonomic value. It occurs in the form of minute granules of irregular form, chiefly in the outer and inner walls of the epidermal cells of the stem and of both surfaces of the leaf, less often in the lateral walls of the same cells.

Presence of a Glucoside in the alcoholic extract of certain plants.‡—M. E. de Wildeman has found in the alcoholic extract of certain plants a substance which will reduce Fehling's solution. The reaction was well marked with an extract obtained from the leaves of the ivy; also with one obtained from the common *Pelargonium*. In the latter case tannin was also present, which was precipitated as a blue-black sediment by salts of iron. The author also prepared alcoholic extracts of certain algæ:—*Ulothrix zonata*, *Ulva Lactuca*, and *Nostoc commune*. In each case Fehling's solution was reduced. The glucoside present in each of the above has not yet been isolated.

Localization and Significance of Alkaloids in Plants.§—MM. L. Errera, Ch. Maistriaux, and G. Clautriaux state that in the majority of cases the alkaloids are found in the interior of the cells, dissolved sometimes in the cell-sap, occasionally in mucilaginous matter.

Alkaloids are distinctly local in their occurrence in the plant. They occur in active tissues such as the growing point or the embryo, or around the fibro-vascular bundles, or in the epidermis, or finally they may occur, as in *Papaver*, in the laticiferous vessels.

Physiologically, they may be considered as the waste products of the activity of the protoplasm.

Alkaloids are formed essentially in the active tissues, where they are decomposed and transformed into albuminoids. From the interior the alkaloids are transported towards the periphery in order that they may be more easily oxidized and to serve as a protection to the plant. When special secretions occur they are used as reservoirs to store the alkaloids.

(3) Secretions.

Caoutchouc in Plants.||—Dr. Kassner has determined the amount of caoutchouc in the latex of several native (German) plants. In *Soucheus oleraceus*, the mean of several experiments gave a percentage of 0.18 per cent. This was accompanied by an unusual proportion of proteinaceous substances (15.62 per cent.) and of potash (52.17 per cent. of the ash). In *Lactuca virosa* he found the proportion of caoutchouc in the fresh latex to be as high as 5 per cent. In *Chelidonium majus* and *Euphorbia Lathyris* only slight traces of caoutchouc were found in the latex. The latex of *Asclepias Cornuti* was also found to contain a considerable quantity of the same substance, but was not examined at the time of the year when the amount was likely to be the largest.

* Bot. Centralbl., xxx. (1887) pp. 154-6.

† SB. K. Akad. Wiss. Wien, xciii. (1886) pp. 231-46 (1 pl.).

‡ CR. Soc. R. Bot. Belgique, 1887, p. 34.

§ Errera, L., Maistriaux, Ch., and Clautriaux, G., 'Prem. Rech. sur la localisation et la signification des alcaloides dans les plantes.' Bruxelles, 1887, 29 pp. and 1 pl.

|| JB. Schles. Gesell. vaterl. Cultur, lxiii. (1886) pp. 128-32, 181-6.

(4) Structure of Tissues.

Concentric Vascular Bundles.*—Herr M. Moebius classifies the cases where the fibrovascular bundles have a central phloëm and a peripheral xylem under five groups, viz.:—(1) The rhizome of Monocotyledons; (2) Monocotyledons with secondary growth in thickness; (3) Dicotyledons in which vascular bundles are formed—usually only at a later period—in the interior of fleshy stems and roots; (4) Bundles in the pith of dicotyledonous stems (this is by far the most numerous group); and (5) Cases difficult to group elsewhere; such as the bundles in the pith of the axis of the inflorescence of *Ricinus* (in these the concentric arrangement is often most strongly displayed). A systematic review follows of the families in which bundles of this kind occur.

Structure of Stomata.†—Dr. G. Haberlandt, referring to Schwendener's description of the structure of stomata,‡ points out that in addition to the outer "hinge," there is often, in addition, an "inner hinge," which may be simply a narrow strip of cell-wall, or may consist of the whole inner wall of the adjacent cells which has remained thin; a very good example of this structure is furnished by the stomata in the stem of the flax-plant.

The structure is described in detail of the stomata in the leaves of a large number of floating plants. The author asserts that the usual statement that these stomata have no power of opening or closing is not correct; the power is, however, much more feeble, and is lost at an earlier period, than is the case with land-plants. It is not dependent also, as in most stomata, on the contact of the bulging ventral walls of the guard-cells, but entirely on the more or less complete approximation of the greatly widened outer cuticular bands. The differentiation of the entire stoma into anterior chamber, central fissure, and posterior chamber, is nearly or entirely lost. The purpose of this structure appears to be to prevent the capillary stoppage of the fissure with water.

Clothing of Intercellular Spaces.§—M. C. van Wisselingh has examined, by the use of staining reagents, the nature of the layer which so often clothes the wall of intercellular spaces. In most cases he finds it to consist of the lignified outermost layer of the cell-wall, often easily separable and sometimes puckered into folds by the unequal growth of the subjacent layer. In the angle where two cells meet it is often raised up so as to form secondary intercellular spaces. A lignified outer layer of the wall adjoining intercellular spaces was determined by the use of reagents in the bark of *Sambucus nigra*, *Ligustrum vulgare*, and *Aucuba japonica*, in the cortex of the rhizome of *Convallaria majalis*, and of the root of *Menyanthes trifoliata*, and in the parenchymatous cells of the mid-rib of the leaf of *Aucuba*.

In other cases, especially in the neighbourhood of the stomata, this layer consists of a suberized or cuticularized substance, as in the large intercellular spaces in the leaf-stalks of *Nymphæa odorata*, and in many leaves. An apparently protoplasmic layer in the intercellular spaces was seen only in the root of *Lycopus europæus*.

Van Wisselingh's observations agree, therefore, rather with those of Schenk than of Russow. He confirms Gardiner's observation that in *Ligustrum vulgare* the clothing of the intercellular spaces consists of a lignified lamella of the cell-wall.

* Ber. Deutsch. Bot. Gesell., v. (1887) pp. 2-24 (2 pls.).

† Flora, lxx. (1887) pp. 97-110 (1 pl.).

‡ See this Journal, 1882, p. 216.

§ Arch. Néerland., xxi. (1887) 15 pp. and 1 pl. Cf. this Journal, 1886, p. 471.

Relation of Secretory Channels to Laticiferous Vessels.*—M. A. Trécul states that as the contents of secretory channels and laticiferous vessels are analogous in physical and physiological properties, he proposes to employ the name laticiferous vessels for both sets of organs. Secretory channels may occur in the root, stem, or leaves. In *Argemone*, *Podostemon*, *Lactuca*, &c., they may be seen forming a network near the surface of the root, while in *Angelica sylvestris*, *Opoponax Chironium*, &c., the channels form a system extending through the whole plant.

The author calls attention to the simultaneous existence in the Compositæ of secretory channels and laticiferous vessels. In the Cichoriaceæ laticiferous vessels with a membranous envelope exist, while in the Senecionideæ and Asteroideæ the oleo-resinous channels have no envelope. In laticiferous vessels the latex is generally in a state of emulsion; rarely the juice is limpid. In the secretory channels, on the contrary, the emulsified condition is rarely found.

The latex of certain plants is decidedly nutritive, and in 1862 the author gave examples of certain Umbelliferae, where the oleo-resinous juice produces true cellules in the interior of the channels. This may also be seen in the branches of *Brucea ferruginea*.

Laticiferous vessels of Calophyllum.†—M. A. Trécul states that in 1865 he described the structure of the leaves of *Calophyllum Calaba*, and pointed out the relation of the channels containing white milky latex to the fibro-vascular system. On the edge of the leaf, in the group of thickened cells forming the edge, there is a channel full of latex running at the side of the marginal vein.

M. J. Vesque has confirmed the observations published by the author in 1865. Spiral vessels were observed attached to the surface of the secretory or laticiferous channels interposed to the secondary veins, in the middle of the parenchyma which separates these parallel veins. These tracheids extend along the side of the channels in the form of bundles, and in transverse section are arc-shaped, and in from one to four layers.

These secretory channels are then surrounded in a great measure by the tracheids; but this is not all, as the tracheids, which are intimately connected with the surface of the secretory channels, communicate with the secondary veins, by bundles composed of narrow tracheids, and some fibres, in the same manner as those which are in contact with the secretory channels. The reservoirs of water are only the spiral cells themselves.

The author concludes that it is the latex which furnishes nutritive elements to the transverse bundles, and to those communicating with the secondary veins.

Anatomical peculiarities of Echites peltata.‡—M. L. de Saldanha has made a study of the stem and leaves of *Echites peltata* Vell. The stem is only a few millimetres in thickness, and contains an extremely astringent juice; its richness in tannin is remarkable. A transverse section of the stem shows the disproportion that exists between the diameter of tracheids, and of certain vessels that are found exterior to the woody cylinder. The diameter of the tracheids is extremely small, while that of the vessels in the periphery is large. The stem also contains laticiferous vessels, the latex being of a yellowish or golden-yellow colour.

Meristem of the Medullary rays of Cytisus Laburnum.§—From an examination of the medullary rays of the laburnum, showing that some of

* Comptes Rendus, civ. (1887) pp. 1034-9.

† Ibid., pp. 27-32.

‡ CR. Soc. R. Bot. Belg., 1887, pp. 62-3.

§ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 144-50 (1 pl.).

the cells of the layer from which they are produced become punctated with thick cell-walls like certain cells of the cortex, while large quantities of starch are formed in their interior, Dr. G. Haberlandt comes to the conclusion that the initial cells of the medullary rays acquire during the winter new functions connected with the transport of sap, and resembling those of the cortex.

(5) Structure of Organs.

Adventitious Roots.*—Sig. N. Terracciano found in a hollow in the trunk of a *Cupressus sempervirens*, two sets of adventitious roots, one above and one below, both variously ramified and independent of one another. After citing other similar cases, the author explains the adventitious production and the ascending course of the roots, by supposing that the lower roots which originated from the cambium layer of the trunk becoming inserted in the hollow, and the upper roots from the cambium layer of the branch descending into the cavity, and that they took their ascending course from compulsion, assisted by the damp mould in the cavity.

Tubercles on the Roots of Leguminosæ.†—From a very exhaustive examination of these structures, Herr A. Tschirch states that he has never found them wanting in any species of Leguminosæ examined, whether annual or perennial; they occur only on the underground organs, and always on the roots, never on underground stems. They are of two kinds, the lupin type and the robinia type.

The first type belongs almost exclusively to the genus *Lupinus*, and is found especially at the crown of the root. The tubercles are here swellings of the central vascular bundle of the root itself, having the appearance of an ordinary hypertrophy, and extending afterwards to other portions of the tissue, and forming a tuberous swelling. In the second and more generally distributed type, the origin of the swelling is always lateral; its mature form varies greatly. The two types vary also widely in their mode of development. In *Lupinus*, the centre of the swelling is occupied by a semicircular or roundish mass of tissue, which Tschirch calls the *bacteroid tissue* (the bacteria of Woronin, bacteroids of Brunchorst), almost always capable of growth. The entire tubercle is surrounded by an envelope of cork; root-hairs are always wanting. Starch is found in this tissue, especially in its early stages. By the time that the seeds are ripe, this tissue has become entirely emptied of its contents, and the tubercle dies away. In *Robinia*, *Phaseolus*, &c., on the contrary, the bacteroid tissue occurs at the apex of the tubercle, and continues to grow as its lower part becomes emptied of its contents.

The author agrees with Brunchorst that the so-called "bacteroids" are not living parasitic organisms, but organized albuminoid structures; the chief arguments for this view being their variable form, the invariable failure of all attempts at culture, and their behaviour towards staining reagents. They appear to approach most nearly in their properties to the group of caseins; and the tubercle must be regarded as a transitory store-house of albuminoid reserve-material, to be used as wanted by the plant, especially in the maturing of the seeds.

With regard to the filiform structures which commonly (but not invariably) accompany the bacteroid tissue, and which have been regarded by previous observers as the hyphæ of parasitic fungi, or as plasmodial

* Rend. R. Accad. Sci. Fis. e Mat. Napoli, 1886, 1 pl.

† Ber. Deutsch. Bot. Gesell., v. (1887) pp. 58-98 (1 pl.). Cf. this Journal, 1886, p. 271.

structures (by Frank as the originators of the bacteria themselves), the author is inclined altogether to doubt their fungal character, and to regard them as of the same nature as the bacteroid tissue itself.

The explanation given by Tschirch of the universal occurrence of these structures in the Leguminosæ, is the unusually large proportion of nitrogen required by this class of plants; they are therefore especially well developed when leguminous plants are grown in a soil containing but a small quantity of humus or nitrogenous constituents. They attain their maximum of development when the plant is in flower, gradually giving up their nitrogenous contents as the seeds ripen. They are not organs of absorption, and, as a general rule, the conversion of nitrates into albuminoids has taken place before the food-material reaches the tubercles.

Swellings on the Roots of the Alder and Elæagnaceæ.*—A fresh examination of these structures has led Herr B. Frank somewhat to modify his own previous view as to their nature, and to differ entirely from those who regard them as due to parasitic fungi. He finds the appearance of a carefully prepared section to differ in no respect from that of an ordinary spongy parenchyma full of protoplasm; and the so-called vesicles, to which such different interpretations have been given, to be nothing but accumulations of newly-formed albuminous substances in the rounded spaces of the originally porous protoplasmic structure.

These swellings are therefore identical in structure and function with the tubercles on the roots of the Leguminosæ as explained by Tschirch. They are organs for the temporary storing-up of albuminoids, to be again dispersed to those parts of the plant where they are required for the formation of new organs. The alleged parasitic fungi *Schinzia Alni* and *Leguminosarum*, *Plasmodiophora Alni*, and *Frankia subtilis*, must therefore be erased from mycology.

Shoots of *Pyrola secunda*.†—Prof. Kjellman describes the structure by means of which the so-called “wandering” of *Pyrola secunda* takes place. It depends on an annual increase and extension of the crown of the root, which promotes the exposure of the flowers and the consequent dispersion of the seeds.

Relationship between Stipule and Leaf.‡—Dr. M. Kronfeld gives further details of his experiments on the effect on a stipulate leaf of removing the stipules. It is only where these are large that the removal of either lamina or stipules appears to have a direct effect on the development of the other. In *Lathyrus Aphaca* and *affinis* the very large stipules appear to be the direct result of a reduction of the lamina to the condition of a tendril.

Comparative Anatomy of Tendrils.§—Herr G. Worgitzky describes the mechanical structure of tendrils in a large number of plants belonging to a variety of natural orders, and summarizes the results as follows:—

The arrangement of the tissues in tendrils or other organs performing the purpose of tendrils, is intimately connected with the requirements of their functions. The mechanical adaptation varies before and after the clinging to a support; this clinging is associated with more or less complete anatomical changes. The mechanical adaptation is also different in

* Ber. Deutsch. Bot. Gesell., v. (1887) pp. 50–8 (1 pl.). Cf. this Journal, 1886, p. 1033.

† SB. Naturv. Studentsällsk. Upsala, Oct. 26, 1886. See Bot. Centralbl., xxx. (1887) p. 94.

‡ Verhandl. Zool.-bot. Gesell. Wien, xxxvii. (1887) pp. 69–80. Cf. this Journal, ante, p. 271.

§ Flora, lxx. (1887) pp. 2–11, 17–25, 33–46, 49–56, 65–74, 86–96 (1 pl.).

the helicoid portions, and in those which are in close contact with the support; in the former case motility, in the latter case rigidity of the coils is the controlling factor, and the anatomical structure of the two regions therefore varies more or less. The two regions agree in the fact that their most important requirements are in connection with unilateral functions, and hence in the structure being dorsiventral. This dorsiventral structure is usually visibly indicated externally in both regions by a broadening on the concave side on a transverse section, commencing either with the origin of the organ, or more often at a later period.

Pitchers of *Sarracenia*.*—Herr P. Zipperer finds in *Sarracenia purpurea*, as in other species of the genus, that the pitcher secretes a fluid containing a diastatic and peptonic ferment, by which insects are killed, and the whole of their soft parts assimilated.

Formation of Hairs.†—Herr F. Krasan discusses the cause of the woolliness of the galls so commonly produced on several species of *Thymus* by the attacks of a *Phytoptus*. The hairs which cover these galls are in no way different from the normal trichomes of the plant, and especially from those which cause the woolliness of the variety *T. Chamædrydrys* var. *lanuginosa*, which frequently grows intermixed with individuals of the glabrous form attacked by the parasite, especially in very sunny situations, or where there are great and rapid alternations of heat and cold.

With these galls on *Thymus* may be compared the morbid structures known as phyllerium or erineum, tufts of hairs on the lamina of the leaf, very common on the vine, alder, lime, and on many herbaceous plants. Though these are generally believed to be caused by the attacks of mites, it is exceedingly difficult to detect the parasite in connection with them, and the disease is especially prevalent after injury by late frosts, followed by a period of intensely hot weather. The author believes that the formation of hairs does not result in these cases from the attacks of the parasite, but that both phenomena are due to the same cause, viz. special vital conditions, and especially the irritation caused by sudden and unusual changes in these conditions. The most prolific cause of irritation is an oversaturation of the organisms with ammoniacal substances and phosphorus salts, and consequent degeneration of the sap. This tendency is materially increased in the case of galls by the irritation resulting from the injury inflicted on the tissues by the parasite.

Normal Position of Zygomorphic Flowers.‡—Dr. F. Noll continues his researches on this subject, his latest observations being chiefly on the obliquely and transversely zygomorphic flowers of the Solanaceæ and Fumariaceæ, those of inverse origin of the Orchideæ, Lobeliaceæ, and Balsamineæ, and on leaves. The mathematical side of the subject is largely illustrated by formulæ. In addition to the ordinary and well-known changes in direction, the phenomena of torsion involve here, in many cases, a new kind of movement, exotropic lateral motion. It is this movement which causes the external position of the organ on its mother-axis, and hence its development in relation to the parent-plant. External forces do not play any direct part in bringing this about; the development is influenced by the mother-plant itself. The assumption of this exotropic motion, which can be experimentally confirmed, explains, in the simplest

* Zipperer, P., Beitr. z. Kenntniss d. Sarraceniaceen. Erlangen, 1886, 34 pp. and 1 pl. See Bot. Centralbl., xxix. (1887) p. 358.

† Oesterr. Bot. Zeitschr., xxxvii. (1887) pp. 7-12, 47-52, 93-7.

‡ Arbeit. Bot. Inst. Würzburg, iii. (1887) pp. 315-71 (8 figs.). Cf. this Journal, ante, p. 266.

way, the various movements in the course of development of the organ in question, even in their details. It is then seen how the normal position is attained in the shortest way; and that, in opposition to the theory of de Vries, the excess of weight on one side is, when necessary, counterbalanced by active tensions. The posterior torsion of flowers which become reversed and then again change their position, is a necessary result of this theory. The simplest case is that in which no torsion takes place during development, but where this is attained by median curvature; and to this all others may be traced. Special cases are treated in detail by the author.

Floral Conformation of *Cypripedium*.* — Dr. M. T. Masters first describes the general conformation of orchid flowers, and then that of *Cypripedium* in particular. The points specially worthy of notice are the lip, the andræcium, and the gynæcium. The andræcium is composed of one median stamen dilated into a broad shield-like staminode, and of two lateral fertile stamens within the preceding. Occasionally pleiomery of the stamens occurs. The author has observed triandrous flowers of *C. barbatum* and *C. Lawrenceanum*; tetrandrous flowers of *Uropedium* and *C. Lawrenceanum*; and hexandrous flowers of *C. Sedeni* ×. Increase in the number of stamens occurs more frequently in the inner staminal cycle than in the outer. Peloria in *Cypripedium*, as in other plants, is either (a) regular, or (b) irregular. The author has observed a case of regular peloria in *C. Sedeni* ×; the usual zygomorphic state being replaced by an actinomorphic condition. Cases of partial irregular peloria in *Cypripedium* are not uncommon.

The changes resulting from hybridization among the *Cypripedia* may be ranged under three categories:—(1) Those in which the changes occur in those characters which are more or less directly of an “adaptive” character. (2) Those in which there is in the offspring a more or less complete reversion to one or other immediate parent. (3) Those in which the change is decidedly teratological, and more or less affecting those “congenital” characters which constitute the symmetry of the flower.

Cupules of Cupuliferæ.†—Herr L. Celakovsky returns to the earlier view of Hofmeister, that the cupule of the true Cupuliferæ is of an axial character. He comes to this conclusion from a comparison of the lowest scales of the cupule of the beech, chestnut, and oak, with the bracts and stipules of the same plants, and from the structure of abnormal examples. The relationships are also discussed between the cupule of the true Cupuliferæ and the corresponding organ in the Corylaceæ.

Resistance of Pollen to External Influences.‡—Dr. P. Rittinghaus has made a series of experiments on the power of pollen-grains to resist extremes of external changes. Their subsequent capacity for germination was tested in a nutrient solution of sugar. He finds that most pollen-grains can resist a temperature of 90° C. for half an hour; the maximum temperature which was found not to destroy life was 104·5° for ten minutes. While low temperatures hinder germination, a lowering to –20° was found not to be fatal. A moderately high temperature (32°) promotes the growth of the pollen-tubes. The protoplasm of pollen is extremely sensitive to antiseptics, usually considerably more so than micro-organisms; poisonous gases have also a fatal influence. The duration of the power of germination of pollen-

* Journ. Linn. Soc. Lond., xxii. (1887) pp. 402–22 (1 pl. and 10 figs.).

† SB. K. Böhm. Gesell. Wiss., Nov. 12, 1886. See Bot. Centralbl., xxx. (1887) p. 10.

‡ Verhandl. Naturhist. Ver. Preuss. Rheinl., xliii. (1886) pp. 123–66.

grains varies between seventeen and sixty-six days, the average appearing to be from thirty to forty. Attempts to influence the direction of the growth of the pollen-tubes were without result.

Nectaries.*—Dr. S. Stadler describes the structure and development of the nectary in seventeen species of plants, with remarks on their mode of fertilization. *Melittis Melissophyllum*, *Cydonia japonica*, and *Oenothera Lamarckiana* have hispid nectaries. The methods of secretion are divided into four classes:—(1) Through uncuticularized tissue, as in *Agave*; (2) Through stomata, as in *Melittis*; (3) Through cuticularized tissue without upheaval, as in *Lilium*; and (4) with upheaval of the cuticle, as in *Diervilla*. *Asclepias Cornuti* has two kinds of nectary. The origin and course of the fibro-vascular bundles are described in the various cases, as well as the chemical reactions of the cell-contents of the nectariferous tissue.

Structure and Development of the Fruit of *Anagyris fœtida*.†—Sig. E. Martel examined separately the development of the epidermis, and then that of the fibrous zone of the pericarp. From the elements of the sub-epidermal parenchyma near the fibrous bundles is formed a second solid layer parallel to the fibrous stratum of the internal epiderm. The elements of these two zones are differently situated, a condition which contributes not a little to facilitate the dehiscence of the fruit. The author shows that in the pericarp of *Anagyris fœtida* there is no germinal zone, as stated by Cave for most fruits, and he concludes his work by refuting the opinions of Cave about the strata of the pericarp, and, although agreeing with Cave's views in general on stems, he declines to accept those relating to the origin of the layers which form them.

β. Physiology.‡

(1) Reproduction and Germination.

Entrance of Pollen-tubes into the conducting Tissue.§—Dr. P. Rittinghaus has studied the way in which pollen-tubes force their way into the conducting tissue of the style. An open canal in the style occurs especially in Monocotyledons. In other cases, of which *Chimonanthus fragrans*, *Camellia japonica*, *Lythrum virgatum*, and some others are given as examples, the surface of the stigma is not cuticularized, and the pollen-tubes find their way with great ease between the cells. But in the great majority of cases a certain degree of resistance is offered to the entrance of the pollen-tubes by the more or less perfect cuticularization of the surface of the stigma.

In these cases it is impossible to conceive that the extremity of the pollen-tube has any power of mechanically breaking through the cuticle; the entrance must be effected by means of solution or absorption. The substance which brings about this absorption is clearly to be found in the protoplasm of the pollen-tube, and is probably a peculiar enzyme. The passage through the cuticle is effected either on a papilla or at the base of one. The cuticle is absorbed by the substance contained in the pollen-tube, and an intimate fusion takes place between the pollen-tube and the papilla, so that the separation between them entirely disappears.

* Stadler, S., Beitr. z. Kenntniss d. Nectarieen u. Biologie d. Blüten, 88 pp. and 8 pls., Berlin. See H. N. Ridley in Journal of Botany, xxv. (1887) p. 157.

† Ann. R. Istit. Bot. Roma, ii. (1886) pp. 51-7 (1 pl.).

‡ This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth; (3) Movement; and (4) Chemical Changes (including Respiration and Fermentation).

§ Verhandl. Naturhist. Ver. Preuss. Rheinl., xliii. (1886) pp. 105-22 (1 pl.).

The details of the process are described in the case of a number of plants belonging mostly to the Silenææ and to the genera *Saxifraga*, *Cucurbita*, *Convolvulus*, and *Salix*.

Fertilization of *Oxalis*.*—Herr F. Hildebrand has made a series of experiments on the fertility of the different forms of the various trimorphic species of *Oxalis*. The following are among the more interesting results:—

Of *O. Lasiandra* the short-styled form is mostly known in cultivation. It propagates itself by bulbs for many generations, and produces the short-styled form only. It is incapable of self-fertilization, but abundance of capsules are produced when brought into contact with the mid-styled form. Of *O. tetraphylla*, *versicolor*, *brasiliensis*, and *compressa*, the long-styled forms are entirely sterile with their own pollen. Of *O. lasiopetala* the mid-styled form is altogether infertile by itself, but produced abundance of seeds in the neighbourhood of the mid-styled *O. articulata*, which germinated into hybrids. The mid-styled forms of *O. obtusa* and *Vespertilionis*, and the short-styled *O. cernua* and *Deppii*, were always sterile with their own forms, and the same is the case with both short-styled and mid-styled *O. bifida*, though this species was fertile if the two forms were intercrossed, and with the three forms of *O. hirta*.

In *O. Bowiei* the short-styled form exhibits a very imperfect fertility when pollinated from its own form, and the same is the case with the mid-styled *O. catherinensis*. Seedlings from this form of this species produced only mid-styled plants, while those resulting from the crossing of short-styled and mid-styled forms gave birth to these forms only, and no long-styled. Similar results were obtained with several other species. In *O. Valdiviana* and *speciosa* each of the three forms displayed a certain degree of fertility when pollinated from its own form, which was stronger in *O. lobata*, *pentaphylla*, and *crassipes*; and in the cases of the mid and long-styled *O. articulata*, the long-styled *O. incarnata*, *rosea*, and *Piotteæ*, and the mid-styled *O. carnosa*, no self-sterility was exhibited.

Fertilization of Scandinavian Alpine Plants.†—Herr C. A. M. Lindman has examined the very rich flora of the Dovrefjeld in reference to the arrangements for fertilization. He finds a distinct tendency to a deeper colour in the flowers than is displayed by the same species in the lowlands, red and blue predominating. The great length of daylight appears to increase the size both of leaves and of flowers, though in some species, on the other hand, the flowers are diminutive in consequence of the low temperature. Crowded masses of small flowers are very common. The number of scented species is comparatively small, though the fragrance is sometimes powerful. The scarcity of insects necessitates that there should almost always be a provision for possible self-fertilization, and many species, elsewhere heterogamous, are here homogamous. Notwithstanding the cold and wet summer (1886), the plants observed almost invariably bore fruit.

Chemistry of Germination.‡—M. A. Jorissen regards the greater part of the nitrogenous substances formed in germination as derivatives of the albuminoids. The result of germination is not always a reducing process. The chief constituents of ash are phosphoric acid, potassa, magnesia, and lime. During germination a transport is effected of these substances from the cotyledons or endosperm to the embryo, this taking place at the expense

* Bot. Ztg., xlv. (1887) pp. 1-6, 17-23, 33-40.

† SB. Naturvetensk. Studentsällsk. Upsala, Nov. 11, 1886. See Bot. Centralbl., xxx. (1887) pp. 125 and 156.

‡ Jorissen, A., 'Les phénomènes chimiques de la germination,' 140 pp., Bruxelles, 1886. See Bot. Centralbl., xxx. (1887) p. 5.

especially of the phosphoric acid, potassa, and magnesia; the proportion of dissolved mineral substance is inverse to the advance of growth.

The author regards the transformation of starch into sugar as a purely chemical change, independent of any micro-organisms, for it is brought about by diastase even in the presence of the most powerful antiseptics. Seeds can therefore germinate without the assistance of these organisms. Ammonium salts are, he states, formed in germination.

Experiments were tried on the formation of solanine and solanidine in the potato, to determine whether they are produced in germination. He finds that they are not reserve-substances, but a diffusible form of nitrogen compounds. Amygdalin is also a plastic substance, and not a simple product of metastasis. It disappears only slowly on germination.

According to the author's observations, starch-grains may resist the unassisted action of diastase for months. In the rapid formation and transformation of the carbohydrates during germination he believes the albuminoids to play an important part, and that they are derivatives of a simpler substance, formic aldehyde.

Calcium is found universally in the cell-wall, and is probably essential to the formation of cellulose. The fatty acids are formed at the expense of the albuminoids, independently of glycerin; on germination, fatty oils are split up into glycerin and a fatty acid. Sugar is not the invariable form assumed by carbohydrates during transport; it is not present in seedling hemp, nor in the epithelium of the scutellum of grasses.

Germination of the Date-palm.*—Although the date-palm comes under the denomination of "desert plants," Herr G. Firtsch finds the structure of young seedlings to present all the features of plants growing in wet situations, and requiring a large amount of moisture for their sustenance, such as the absence of root-hairs. The development of the seedling, and the structure of its various parts, are described in detail.

(2) Nutrition and Growth.

Apical Growth of Leaves.†—Herr P. Sontag has investigated the duration of the apical growth in leaves belonging to various divisions of the vegetable kingdom. In *Nephrolepis* and the *Gleicheniaceæ* the apical growth is unlimited, while in most *Filicinae* it ceases after the formation of the lateral lobes. The same is the case in some *Cycadeæ*. In the leaves of *Coniferæ* apical growth ceases early, while intercalary growth may continue for several years. In *Monocotyledons* apical is very inconsiderable compared to intercalary growth.

In the leaves of *Dicotyledons* there are three types, viz.:—(1) Intercalary; apical growth ceases soon, when the leaf has attained a length of from 0·5–2 mm., the lateral portions being formed from a point below the apex. (2) Apical; all the lateral portions are formed in acropetal succession from the apex; this mode is specially characteristic of *Umbelliferae*. (3) Mixed, some of the lateral parts being formed from the apex, others from an intercalary growing point; this is the case in all *Compositæ*.

Chlorophyllous Assimilation.‡—Prof. T. W. Engelmann replies to the objection against his statement that the maximum absorption of carbon dioxide by green leaves takes place in the red of the spectrum, founded on

* SB. K. Akad. Wiss. Wien, xciii. (1886) pp. 342–54 (1 pl.).

† Sontag, P., 'Ueb. Dauer d. Scheitelwachstums u. Entwicklungsgesch. des Blattes,' 31 pp., Berlin, 1886. See Bot. Centralbl., xxx. (1887) p. 9.

‡ Bull. Soc. Belg. Micr., xiii. (1887) pp. 327–33.

the fact that Draper, Sachs, and others find a maximum assimilation in the yellow. He believes the apparent contradiction to arise from the circumstance that the observations of these experimenters have been made on leaves of considerable thickness, where the grains of chlorophyll lie one behind another. The thicker the absorbing layer of chlorophyll, the more—admitting the relationship between the absorption of light and its assimilating power—must the maximum of the disengagement of oxygen approach the maximum of energy in the spectrum, moving therefore from the region B-C in the red towards the region D in the yellow. If the incident light were completely absorbed by the leaf, the amount of disengagement of oxygen in each spot of the spectrum would be proportional to the luminous energy of that spot. If there is a smaller amount of available carbon dioxide than a grain of chlorophyll can decompose, it is evident that the whole of this carbon dioxide will be decomposed; and, under these conditions, as large an amount of oxygen will be given off in the yellow or green part of the spectrum as in the red; and the maximum assimilating power will be displaced towards the regions of less absorption, i.e. towards the yellow and green.

Action of the Ultra-violet Rays in the Formation of Flowers.*—Prof. J. Sachs gives details of the experiments from which he has come to the conclusion that the ultra-violet and invisible rays of the solar spectrum are especially efficacious in the development of flowers. The experiments were all made on *Tropeolum majus*. If the rays of the sun are made to pass through a solution of sulphate of quinine, the ultra-violet rays are entirely absorbed or transformed into rays of less refrangibility, and which are visible and of a light blue colour. If a plant is made to grow behind a screen of sulphate of quinine the vegetative organs are normally and luxuriantly developed, but the flowers are almost entirely suppressed. Twenty-six plants thus grown produced only a single feeble flower, while twenty plants grown under similar conditions behind a screen of water of the same thickness produced fifty-six flowers.

Prof. Sachs believes that extremely small quantities of one or more substances formed in the leaves cause the formative materials which are conveyed to the growing points to take the form of flowers. Acting like ferments, an extremely small quantity of these flower-forming principles may act upon large quantities of plastic substances. It may be assumed then that there are three distinct regions of the solar spectrum, differing in their physiological action—the yellow rays and those near them cause the decomposition of carbon dioxide, and are active in assimilation; the blue and the visible violet rays are the agents in movements of irritation; the ultra-violet rays are those which produce in the green leaves the substances out of which the flowers are developed.

Chlorophyll-function of Leaves.†—Herr A. Nagamatz has determined by experiment the three following points, viz.:—(1) Leaves of land-plants, when completely submerged, do not assimilate; (2) after light has passed through one leaf, it has no power of inducing assimilation in a second leaf; (3) no starch is produced in withered leaves. The experiments were made on a number of different plants.

Absorption-bands.—Herr F. Stenger ‡ contests Reinke's conclusion that a maximum of absorption does not always correspond to a visible absorp-

* Arbeit. Bot. Inst. Würzburg, iii. (1887) pp. 372-88 (2 figs.).

† Ibid., pp. 389-407.

‡ Bot. Ztg., xlv. (1887) pp. 120-6. Cf. this Journal, 1886, p. 651.

tion-band in a spectrum. In solutions of chlorophyll in ether and of purpurin in alum he obtains different results from Reinke.

To this Reinke replies * that in the case of purpurin Stenger's results are vitiated by the use of a solution in alum instead of one in alcohol; and with regard to alcohol, repeating the experiments with a solution of the chlorophyll of *Elodea canadensis* in alcohol, and one of *Aspidistra elatior* in ether, he confirms his previous results that the chlorophyll-band III does not correspond in either case to a maximum of the absorption-curve.

(3) Movement.

Movements of Tendrils.†—Prof. D. P. Penhallow has investigated the mechanism of movement in *Cucurbita*, *Vitis*, and *Robinia*. He agrees with Gardiner and others in connecting the phenomenon of continuity of protoplasm with that of a distinct transmission of impulses to parts at a greater or less distance from the centre of irritation. This continuity appears most prominently in the collenchymatous tissue of the rather thick hypoderm; it may also be observed in the meristem of all parts external to the xylem-portions of the vascular bundles.

The results are, to a large extent, confirmatory of those already published. With regard to the average rate of movement; from a total of 436 distinct observations on *Cucurbita maxima* and *Pepo* under all conditions of temperature and humidity, the average rate of movement was found to be 0.316 cm. per minute. The maximum rate varies very widely; occurring in waves in the same tendril.

In the case of *Vitis cordifolia*, the main facts were found to be in general accordance with those of *Cucurbita*. Movements of circumnutation were found to arise through unequal growth of the tissues, represented chiefly by the vibrogen bands. The bands of more active growth are strictly localized. Movements due to irritation depend upon continued elongation of the opposite side, together with cessation of growth and contraction in the irritated parts.

In *Robinia pseudacacia* the leaves are characterized by a nyctitropic or true sleep movement. The soft tissue of the pulvinus is that in which the variations of tension under external influences is determined. The pulvinus of the whole leaf appears to determine the upward movement, while the included fibrous elements determine the downward and reflex movements. The various stages in the movements of the leaves and leaflets are described in detail.

Additional observations are also given on plants belonging to 22 species of 9 genera of Cucurbitaceæ, and the points described in which the tendrils differ from those of *Cucurbita*.

Rotation of Tendrils.‡—Herr J. Wortmann states that rotating movements sometimes take place in tendrils, in which the angles produced by the rotation change, thus resembling in all respects the movements of twining stems. As a rule the movements of tendrils are very much more irregular than those of twining stems; nor is the constancy of the same species always maintained as respects rotating to the right or to the left; occasionally the same tendril will coil in two opposite directions in different parts. With regard to geotropism, Herr Wortmann states that tendrils exhibit this property in the negative sense. Experiments which serve to demonstrate this are described in detail.

* Bot. Ztg., xlv. (1887) pp. 271-5.

† Trans. Roy. Soc. Canada, iv. (1886) pp. 49-83 (3 pls.), and Canadian Record of Sci., ii. (1886) pp. 241-50. Cf. this Journal, 1886, p. 652.

‡ Bot. Ztg., xlv. (1887) pp. 49-55, 65-72, 81-6, 97-100, 113-20, 138-41 (4 figs.).

Elasticity of Flexion in Vegetable Organs.*—Dr. E. Detlefsen describes an instrument and experiments by means of which he estimates what he terms the rigidity of the parts of plants, i. e. their power of resistance to forces which cause them to bend.

The apparatus consists of two perpendicular supports with knife-edges, on which rests the object the elasticity of which is to be tested. This is bent by weights suspended to a ring, attached by means of silk threads to a strong wire laid across the middle of the object. The changes of position of the object are observed in a mirror fixed to one end of the apparatus.

(4) **Chemical Changes (including Respiration and Fermentation).**

Intramolecular Respiration.†—Herr N. W. Diakonow has followed up his previous researches on the chemical conditions of cellular life by a series of experiments on cotyledons, seedlings, &c. His general conclusions are as follows:—(1) The intensity of the liberation of carbonic anhydride by vegetable cells in the absence of the oxygen of the air is determined by the processes of fermentation which take place within these cells; (2) the chemical action of free oxygen and the process of fermentation represent two chemical conditions which may replace one another in the metabolism of a vegetable cell: (3) without the chemical action of free oxygen, or without the aid of the process of fermentation, which is the only means of satisfying the requirements of a cell for oxygen in a medium in which this gas is not present, there is no liberation of carbonic anhydride, that is to say, no life.

Changes in the Proteids in the Seeds which accompany Germination.‡—Mr. J. R. Green corroborates v. Gorup-Besanez's conclusion that a proteolytic ferment exists in seeds during germination.

Seeds of *Lupinus hirsutus* were germinated for a week: they then gave an acid reaction. They were divested of their coats, the cotyledons were ground; the powder was extracted with glycerin and the extract dialysed till no trace of crystalline bodies formed during germination were to be found in the dialysate. The digestions were made in tubes of dialysing paper, so that the fluid outside enabled the author to see if peptone were formed or not. No trace of peptone passed the dialyser after a week's exposure.

The extract was acidified with 0.2 per cent. HCl, some boiled fibrin added, and left at a temperature of 40° C. The process of digestion was slow; but after a time a distinct biuret action was obtained. The course of digestion of the seed proteids was confirmed by examination of the seeds at different stages in natural germination. In addition to the biuret test the following test was also used:—The solution is freed from all other proteids by boiling with freshly prepared ferric acetate, and then treated with acetic acid and phosphotungstate of soda: peptone is thus precipitated.

The author summarizes his results thus:—

1. There exists in the seed of the lupin when germinating a proteolytic ferment which will convert fibrin into peptone, and then into leucin and tyrosin (thus extending v. Gorup-Besanez's result).

2. This exists in the resting seed in the form of a zymogen, which is easily converted into the ferment.

3. The ferment acts best in a slightly acid medium; its activity is

* Arbeit. Bot. Inst. Würzburg, iii. (1887) pp. 408–25 (4 figs.).

† Arch. Slav. Biol., iii. (1887) pp. 6–25.

‡ Proc. Roy. Soc. Lond., xli. (1886) pp. 466–9.

hindered by neutral salts and destroyed by alkalis; and it is most active at a temperature of 40° C.

4. The process of germination is started or accompanied by a transformation of the zymogen into ferment on the absorption of water and the development of vegetable acids in the cells of the seed.

5. The ferment so developed converts the proteids of the resting seed into acid albumin or parapeptone, peptone, and crystalline amides.

6. The nitrogen travels from the cells of the seed to the growing points in the form of the latter bodies, and not in that of peptone or other proteids.

7. General.

Myrmecophilous Plants.*—In an exhaustive treatise on this subject Prof. F. Delpino distinguishes three different ways in which ants are attracted to plants, viz.:—(1) By honey-glands or extra-floral nectaries; (2) By the formation of special minute organs which serve to attract ants; (3) By the formation of receptacles in which the ants live. Of these, the first is by far the most common, the two latter occurring only in a few tropical plants. In the present publication, which is the first portion only of the treatise, the author enumerates a very large number of species provided with extra-floral nectaries, belonging to about thirty natural orders; of these the Leguminosæ include the greatest number. Delpino considers that ants and wasps play a most important function in the life of many plants, as the most active destroyers of their greatest enemies, such as caterpillars and the larvæ of other insects.

Effects of Low Temperatures on Plants.†—Prof. W. Detmer records several instances in which seeds can be exposed to very low temperatures (– 10° C.) without being killed, though, when they do germinate, the process is very much retarded. In some cases a temperature of – 17° C. is not sufficient altogether to kill tissues, and this is also the case with bacteria.

Goebel's 'Outlines of Classification and Special Morphology.'‡—This book is an expansion of Part II. of Sachs's 'Text-book of Botany,' but is in great part rewritten. The various groups of plants are taken up from the Thallophytes to the Phanerogams, and the main points of their morphology described. In Flowering Plants, the German classification of Angiosperms is still retained, which differs widely from that of Bentham and Hooker, universally adopted in this country. But Sachs's classification of Thallophytes, dependent entirely on the mode of reproduction, is abandoned, and they are divided into five primary groups:—Myxomycetes, Diatomaceæ, Schizophyta (Cyanophyceæ and Schizomycetes), Algæ (including Protococcaceæ and Characeæ), and Fungi. The work may be accepted as embodying the results of all the most recent observations on the structure of the various groups of plants.

B. CRYPTOGAMIA.

Development of Spermatozoids.§—Mr. Douglas H. Campbell describes the structure and development of the spermatozoids in several species belonging to the Filices, Rhizocarpeæ, and Muscineæ. His observations

* Mem. R. Accad. Sci. Bologna, vii (1886). See Bot. Centralbl., xxx. (1887) p. 38.

† SB. Gesell. Bot. Hamburg, April 22, 1886. See Bot. Centralbl., xxix. (1887) p. 379.

‡ Goebel, K., 'Outlines of Classification and Special Morphology of Plants.' Translated by H. P. F. Garnsey; revised by Prof. J. B. Balfour. 515 pp. and 407 figs. Oxford, 1887.

§ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 120-7 (1 pl.).

agree in the main with those of Flemming with regard to the development of the spermatozooids in *Salamandra*. He regards the "head" of the spermatozoid of animals as strictly homologous to the "body" of that of plants.

Since the latest division of the mother-cells of all spermatozooids takes place nearly or quite simultaneously, the further development of the spermatozooids advances with uniform rapidity, so that all those in an antheridium are ripe at the same time. The walls of the mother-cells remain until the spermatozooids are nearly mature; then they are partially absorbed, and the separate cells become isolated, and at first still inclosed in a thin pellicle. Notwithstanding the small size of the nucleus, it is certain that it consists of an ordinary framework with relatively large microsomes.

The differentiation of the young spermatozoid begins with a contraction of the substance of the nucleus. On one side is found a more or less distinct fissure or constriction, so that the nucleus has a sickle-shaped appearance from above. The contracted framework of the nucleus has now the form of a thick curved band, the ends of which approximate, and the margins are bent inwards. As development proceeds this band becomes thinner and flatter, until it assumes its final form of a coiled thread. The change of form is accompanied by a corresponding internal differentiation. The reticulate structure gradually disappears, and the strongly refractive body of the spermatozoid becomes finally nearly homogeneous. If it is now stained with hæmatoxylin or saffranin, it is easily seen that the microsomes are still separated, while in the mature spermatozoid the whole of the band takes a uniform intense colouring.

The body of the spermatozoid is therefore formed out of the nucleus of the mother-cell. Their behaviour towards reagents shows that the cilia originate from its cytoplasm. They are formed only during the latest stage of development of the spermatozoid. The development of the vesicle, which is always present, advances *pari passu* with that of the spermatozoid. It results from the constriction which accompanies the first contraction of the nucleus, and increases in proportion as the nucleus contracts. The curved ends of the growing spermatozoid completely inclose it. It has an outer extremely thin wall, which is difficult to detect. It is clear that the vesicle is derived from the cytoplasm, which accounts for the presence in it of starch.

The fixing materials used in these observations were alcohol, a concentrated aqueous solution of corrosive sublimate, a 1 per cent. solution of chromic acid, and a concentrated aqueous solution of picric acid. The most convenient staining material, after fixing with alcohol or corrosive sublimate, is a very dilute aqueous solution of hæmatoxylin. Gold chloride often gave striking results after treatment with chromic or picric acid. Saffranin was also useful in some cases.

Cryptogamia Vascularia.

Prothallium and Germ-plants of *Lycopodium inundatum*.*—Further examination by Prof. K. Goebel of the prothallium of *Lycopodium inundatum* confirms previous observations. It agrees with the type of *L. cernuum* rather than with that of *L. annotinum* and *Phlegmaria*, growing erect, and containing chlorophyll in the portion above the surface. The cells are attacked by the hyphæ of a fungus, probably a *Pythium*, in the same way as the prothallium of *L. cernuum*. Antheridia and archegonia occur in close contiguity on the same prothallium. The young plant has a single

* Bot. Ztg., xlv. (1887) pp. 161-8, 177-90 (1 pl.). Cf. this Journal, 1886, p. 828.

cotyledon, and is distinguished from all other vascular cryptogams by the absence of a root, its place being supplied by a tuberos swelling, from which proceed a number of root-hairs; the cotyledon not unfrequently contains no vascular bundle. The stem-bud lies laterally beneath the cotyledon. A non-sexual mode of propagation was observed in the formation of adventitious shoots on leaves when detached from the young plant.

Anatomy of the Sporangia of Ferns.*—Continuing his previous researches on this subject,† Herr J. Schrodtt contests the statement of Prantl‡ that no air penetrates from the outside into the interior of the sporange, so as to cause its rupture. He states that the cells of the annulus of the ripe sporange contain water which evaporates through the thin membrane into the air. In this way the ends of the supports approach, the annulus is stretched, and the sporange ruptured at its thinnest spot. At the moment when the membrane which has become drawn into each cell of the annulus reaches its lowest point, and the surface of the inclosed water cannot sink any lower, a vacuum results, into which air is forced from without; and since this takes place at the same time in all the cells, the springing apart of the supports to which the spores are attached causes the latter to be violently thrown out.

Formation of Crystals in the Marattiaceæ.§—According to Herr N. A. Monteverde, the tabular crystals found in the parenchymatous cells of the Marattiaceæ do not consist, as previously supposed, of calcium and magnesium sulphate, but of calcium oxalate. Calcium sulphate does, however, occur dissolved in the cell-sap, and becomes separated in the form of sphærocrystals if the leaves of *Angiopteris longifolia* or *Marattia cicutæfolia* are laid for months in alcohol.

Apogamy in Ferns.¶—Herr F. F. Stange describes the development of the apogamous prothallium in *Todea rivularis*, *T. pellucida*, and *Dodea caudata*, directly into the young plant. The anterior portion of the prothallium thickens into a solid mass of tissue, from the lobes of which the fronds are developed. He also describes the propagation of *Mohria thurifraga* by hibernating prothallia produced directly from tubercles somewhat resembling those of *Gymnogramme*.

Apospory in *Polystichum angulare* var. *pulcherrimum* Willd.¶—Mr. C. T. Drury has obtained specimens of *Polystichum angulare* var. *pulcherrimum*, in which, as soon as the fronds attained the length of 6 in. or so, the tips of the pinnules began to run out and dilate into prothalli, until the pinnae were absolutely fringed with them. So far, the phenomena observed had been precisely similar to those noticed in Padley's form; but upon a closer examination, hydræform bodies attached to the upper surface of the pinnules, and within the margin, were noticed. These were in every case produced at the ends of excurrent veinlets protruding from the surface of the pinnules, and thickening at the distance of about 1/20 in. into a pear-shaped body, from which radiated in all directions numerous root-like hairs. Gradually this grew into an undoubted prothallus, though much thicker in substance than those produced by extension of the pinnule tips. From these observations it

* Flora, lxx. (1887) pp. 177-92, 202-8.

† See this Journal, 1886, p. 828.

‡ Ibid., 1886, p. 1020.

§ Arbeit. St. Petersburg. Naturf. Gesell., xvii. (1886) pp. 33-4. See Bot. Centralbl., xxix. (1887) p. 358.

¶ SB. Gesell. Bot. Hamburg, March 25, 1886. See Bot. Centralbl., xxix. (1887) p. 351.

¶ Journ. Linn. Soc. Lond., xxii. (1887) pp. 437-40 (3 figs.).

will be seen that the formation of a prothallus in this case is preceded by a very different series of phenomena from those previously recorded.

Structure of *Davallia Mooreana*.*—M. P. Lachmann states that the horizontal rhizome of this fern is composed essentially of two vascular bundles, which anastomose alternately right and left, and pass into two dorsal rows of leaves. The supporting tissue is composed of fusiform groups of fibres arranged irregularly round the conducting bundles; these fibres have their cavity filled with calcium oxalate, a peculiarity rare among vascular cryptogams.

Root of *Hymenophyllaceæ*.†—Contrary to the statement of Russow and Prantl, that there are always two vascular bundles in the root of *Hymenophyllum*, and either one or more than two in that of *Trichomanes*, M. P. Lachmann finds occasionally three bundles in the root of *H. demissum*, and always two in that of *T. spicatum*, *radicans*, and *spinosum*.

Rhizodendron.‡—Dr. K. G. Stenzel gives a minute description of *Rhizodendron Oppoliense*, a fossil tree-fern from the cretaceous marl near Oppeln. In close proximity to it are found also the remains of two other tree-ferns with which it might easily be confounded, *Protopteris fibrosa* and *P. Cottæana*, which are also described.

Muscineæ.

Protonema of Moss resembling *Chroolepus*.§—Dr. A. Hansgirg believes that many of the structures generally believed to be independent organisms, and described under the names *Trentepohlia*, *Chroolepus*, and *Gongrosira*, are in reality the protonemata of mosses. This is especially the case with *Chroolepus umbrinum*, *quercinum*, and *odoratum*, and *Trentepohlia uncinata* and *lagenifera*, and possibly also with *C. iolithus* and *rupestre*. He has repeatedly been able to trace the passage of the protonemata of mosses into protococcus- and palmella-forms. In moss-protonemata closely resembling *T. lagenifera*, he has been able to detect the development of zoosporangia corresponding, in position and size, to the normal zoosporangia of this alleged alga.

Glistening Apparatus of *Schistostega osmundacea*.||—Dr. P. Vuillemin graphically describes the life-history and habit of the moss *Schistostega osmundacea*. In the deep damp fissures between stones the protonema generation flourishes, and the sexual phase becomes rare. The histological structure is briefly described. In specimens examined when fresh or after being fixed with osmic acid, it is seen that all the chloroleucites are accumulated in the protoplasmic mass at the posterior part of the cell, and there form a continuous pigmented layer, on which the anterior lens of hyaline matter concentrates the luminous radiations. As the incident radiation is diverted from the optimum, the chlorophyll-bodies become dispersed in the parietal protoplasm. The author describes the various arrangements of these bodies in response to the varying intensity of radiation. The glistening protonema can survive where the ordinary form would probably perish. Its propagation is effected by the stolon-like growth of the globular cells touching the soil, or by the formation of actual conidial spores from the highest cells

* Bull. Soc. Bot. Lyon, Avril 13, 1886. See Bull. Soc. Bot. France, ix. (1887), Rev. Bibl., p. 3.

† Ibid., Mai 11, 1886. See Bull. Soc. Bot. France, ix. (1887), Rev. Bibl., p. 3.

‡ JB. Schles. Gesell. vaterl. Cultur, lxiii. (1886) 30 pp. and 3 pls.

§ Flora, lxx. (1887) pp. 81-5.

|| Journ. Anat. et Physiol., xxiii. (1887) pp. 18-30 (1 pl.).

of the refractive tufts. The details of this special mode of reproduction are described.

In considering the glistening property of the cells, the author reviews the incipient "eyes" of forms like *Peridinea*, and emphasizes the probability of the "eye" being primitively trophic rather than sensory. Besides the sensory function, the primitive "eye" is adapted to the absorption of solar energy. Nor is this primitive function wholly lost in higher grades of evolution.

Formation of Pores in Sphagnaceæ.*—According to Herr K. G. Limpricht, the presence of pores in the cortex of the stem of Sphagnaceæ is a more general phenomenon than is usually supposed, occurring universally, except in the *cuspidatum*-group. Besides the sharply defined pores, there are also frequently in the leaves larger irregular orifices in the cell-wells caused by resorption. Both kinds of orifice are connected with the more or less abundant formation of fibres.

Algæ.

Structure and Development of the Thallus in Florideæ.†—M. M. F. Debray describes the structure and development of the thallus in the genera *Chylocladia*, *Champia*, and *Lomentaria*. At the growing point are a number of apical cells having their apices in close contact, which divide repeatedly by transverse septa independently of one another, producing rows of cells. The divisions in the different rows correspond to one another so closely as to produce a uniform tissue. Each cell of these hyphæ divides immediately beneath the growing point by a longitudinal wall, the cortical cells being in this way separated. The cortical cells divide again by walls placed vertically to the surface but irregularly, a connected layer being thus formed which surrounds the whole of the branch.

The branching of the thallus is either dichotomous or lateral; and adventitious shoots may arise on older parts of the thallus when the cortex consists of only a single layer; or they are formed without any definite position from inner cortical cells.

Parasitic Alga of *Emys europæa*.‡—Dr. A. Peter discovered in the horny tissue of the carapace of *Emys europæa* a chlorophyllaceous alga, *Dermatophyton radians*, which forms fronds with a diameter of even 13 mm. The alga penetrates the horn and by its growth eventually forms a cup-shaped projection. It is a real parasite, as it derives its nourishment from its host.

Padina.§—Dr. F. Hauck proposes to classify the various forms belonging to this genus, hitherto considered as constituting one species only, under three groups, viz.:—

(1) Reproductive organs developed on both sides of every second filament-zone, forming, when ripe, double zones, separated from one another by a more or less conspicuous filament-zone. (Type: *P. pavonia*.)

(2) Reproductive organs developed on the upper side of every second filament-zone, forming, when ripe, intermediate bands between each second interstice formed by the filament-zones. (Type: *P. Commersoni*.)

* JB. Schles. Gesell. vaterl. Cultur, lxiii. (1886) p. 199. Cf. this Journal, 1886, p. 656.

† Bull. Scient. Départ. du Nord, ix., 14 pp. and 4 figs. See Bot. Centralbl., xxix. (1887) p. 354.

‡ SB. Gesell. f. Morphol. u. Physiol. Münch., ii. (1887) pp. 117-8.

§ Hedwigia, xxvi. (1887) pp. 41-5.

(3) Reproductive organs developed on the upper side of each filament-zone, forming, when ripe, (often only rudimentary) intermediate bands between the successive interstices formed by the filament-zones. (Type: *P. variegata*.)

The comparatively rare oogonia and antheridia are arranged in the same way as the much more frequent tetrasporangia. Several new species are described belonging to each of the above groups.

Formation of Cysts in Ulothrix.*—M. E. de Wildeman records the formation of exogenous cysts in the sense in which the term is used by Gay,† in several species of *Ulothrix*. They appear to be formed under conditions of insufficient supply of moisture or nutriment, and constitute probably the only mode of propagation when the plant grows on the trunks of trees, on moist soil, or otherwise exposed to the air.

Allogonium.‡—Dr. A. Hansgirk claims priority for this generic name, including under it five species of Ulotrichaceæ, hitherto placed in different genera. He now sinks his own genus *Chroodactylon* as a section of *Allogonium*.

New Parasites of Daphniæ.§—M. R. Moniez has found a new species of *Amœbidium* (which he calls *A. cienkowskianum*) on several *Daphniæ* at Lille; a study of its characters has shown him that *Amœbidium* is a parasitic form of the free genus *Raphidium*, one of the Palmellaceæ; another new species is called *A. crassum*, and it is an endoparasite, having been taken from the intestine of *Eurycerus lamellatus*. The name of *Chytridhæma cladocercarum* has been given to a parasite of *Simocephalus retulus* and *Acropus leucocephalus*; its zoospores are extraordinarily abundant in the blood, and are almost 3 μ at their greatest width; its contents vary considerably, and it appears to recall at one and the same time the Chytridiæ, Olpidiæ, and Ancylistæ.

Another type of parasite, which must be placed with the Gymnoasceæ, is *Botellus*; *B. typicus* is a parasite of *Daphnia reticulata*, in the genital organs of which it is developed; *B. parvus* is found in *Cypris vidua*. The psorosperms or spores of fungi noted by various observers in the circulating apparatus of Daphnids have been investigated by the author, who groups them as (1) *Microsporidia obtusa* from *Simocephalus retulus* and *Daphnia reticulata*; *M. ovata* from *S. retulus* and *Chydorus sphaericus*; *M. elongata* from *S. retulus*; *M. acuta* and *M. incurvata* from *Daphnia pulex*.

Mountain Algæ.||—Dr. A. Hansgirk compares the algal flora of the mountain-region of Bohemia with that of the lowlands and plains. A large number of the species comprising the latter occur also in the former region, chiefly cosmopolitan species; but there are also many peculiar to the higher altitudes, though the total number of species is smaller. The moist silurian limestone rocks in the neighbourhood of Prague have a peculiar algal flora, several very rare species, belonging especially to the Phycochromaceæ, being found in the clear springs and brooks in this region; and a different flora is again characteristic of the primary mountains of Bohemia. The floræ of the carboniferous, cretaceous, and tertiary formations of Bohemia are less rich and more uniform, but include some rare species of Phycochromaceæ. A list is given of some species belonging to all classes found only at great altitudes in the Riesengebirge.

* CR. Soc. R. Bot. Belg., 1887, pp. 52-5.

† See this Journal, ante, p. 277.

‡ Hedwigia, xxvi. (1887) pp. 21-3.

§ Comptes Rendus, civ. (1887) pp. 183-5.

|| Oesterr. Bot. Zeitschr., xxxvii. (1887) pp. 13-17, 54-8, 97-101.

Endochrome of Diatoms.*—Sig. M. Lanzi records several instances of the occurrence of granular endochrome in placochromatic, and of undivided endochrome-disks in coccochromatic diatoms. In the former case the girdle-bands were always broad, from which the author concludes that propagation took place by division of the cell-contents. *Amphora ovalis* he has seen in various stages of development without previous conjugation or formation of resting-spores. *Nitzschia Palea* he has also been able to trace in its development from very minute gelatinous spores.

Raising Diatoms in the Laboratory.†—Prof. S. Lockwood gives various details of a series of experiments he has been making on raising diatoms in a laboratory. An experiment made in Dec. 1882, and since frequently confirmed, demonstrated that diatoms originate from spores. These spores are exceedingly minute, passing easily through filter-paper. They are probably immotile resting-spores, and may be held in suspension a while, like the mineral matters in turbid water. The viability of these spores is remarkable. The diatoms raised in one series of experiments were from spores whose life-force had lain dormant in total darkness for thirteen or fourteen years; and in another series sixteen years. The viability of some genera is greater than that of others. This is notable of *Navicula* in these experiments, and is consonant with the numerical lead of this genus in forms or so-called species.

Owing to the environment becoming abnormal, development may be rapid and erratic to a surprising degree, but upon aberrant and asymmetrical lines. Suppressed at some points, the life-energy is precociously active at others. Diatoms have embryonal stages or forms, with silicate fronds. As to kind and quantity, the crops are capricious and vary without apparent reasons. As to the parentage of the spores, they were not in these experiments generated in the vessel, but were derived from sporangial mother-cells.

The author performed in all twenty experiments; he found that the diatoms generated could be referred to three genera, i.e. *Nitzschia*, *Amphora*, and *Navicula*.

A table containing the measurements of each accompanies the paper: *Nitzschia* varies from 1/430–1/414 in. in length and 1/4000–1/6000 in. in thickness, *Amphora* from 1/1090–1/1500 in. in length and 1/2570–1/5000 in. in thickness, and *Navicula* from 1/1090–1/4000 in. in length and 1/4500–1/12,000 in. in thickness.

Fungi.

Latex-receptacles of Fungi.‡—Dr. G. Istvánffy and Dr. O. Johan-Olsen classify the latex-receptacles and similar structures of the higher fungi under three heads, viz. (1) Latex-receptacles proper; (2) oil-receptacles; (3) pigment-receptacles, or those which contain a substance which colours in the air.

The latex-receptacles proper or latex-tubes are of large diameter compared to the surrounding hyphæ, have a very soft extensible cell-wall, and exude, on being cut, a turbid finely granular fluid varying in colour according to the species. Their form does not vary greatly; they are seldom divided by transverse septa, but are usually much branched; they are connected with the contiguous tissue-hyphæ, and are often curved or

* Atti Accad. Pontif. Nuovi Lincei, xxxvii. (1886). See Bot. Centralbl., xxix. (1887) p. 321.

† Journ. N.Y. Micr. Soc., ii. (1886) pp. 153–65 (2 pls.).

‡ Bot. Centralbl., xxix. (1887) pp. 372–5, 385–90.

spirally coiled. In *Lactarius*, *Mycena*, and some Polyporeæ they contain a true latex; in other Polyporeæ and in *Fistulina* a fluid containing tannin; in some Agaricineæ again they contain a more or less clear sap. Their origin is usually the same, as lateral buddings from mycelial filaments. Their distribution varies greatly, and may be arranged under three types, viz. :—

(1) The *Lactarius*-type. In most species of this genus the greatest number of latex-tubes occur in the subhymenial layer, and in the periphery of the stipes; the former branches on the one hand into the hymenium, on the other hand into the tissue of the pileus. According as the cortex consists of one or more layers, these tubes are also in a single or a double layer. In the pileus they run either parallel or obliquely to the surface of the lamellæ.

(2) The *Mycena*-type is much more simple. The latex-tubes are extremely long, running through the periphery of the entire stipes, and ending in the central tissue of the pileus. There is no subhymenial layer of latex-tubes.

(3) The *Fistulina*-type. The latex-tubes are distributed through the entire receptacle, and are not collected in definite spots; comparatively few are found in the hymenium.

The latex-tubes pass by insensible gradations into the oil-receptacles, which differ from the former more in their contents than their form. The substance contained in them is usually dense and strongly refractive during the greater part of their period of growth; though in some species of *Stereum* and *Corticium* it is a turbid fluid. These tubes are always undivided and seldom branch; their walls are thin and soft; the parietal layer of protoplasm can be detected throughout their existence, and often contains several nuclei. Their form is either that of long tubes, short cells swollen into a club-form, or spherical cells. They are formed in the same way as the latex-tubes, often in the mycelium.

The pigment-receptacles show no sharp distinction from the oil-receptacles. They occur in many species of *Lactarius* and *Mycena*, where the substance is of a very similar nature, and often assumes a bright colour only on exposure to the air. In many poisonous species of *Boletus* they contain the poisonous principle dissolved in the cell-sap. These receptacles are usually slender much-branched tubes; they are most abundant in the periphery and basal parts of the stipes, but occur also in the pileus and hymenium.

Cystidia of Fungi.*—Dr. R. v. Wettstein regards these structures of the Hymenomycetes as having very different physiological values in the different genera. In *Coprinus* they are at first protective organs for the young spores in the course of their development. In the mature receptacle they serve partly the same purpose, or they fuse together, or force themselves into the neighbouring lamellæ, preventing the rupture of the pileus. The author considers them as but of little value for taxonomic purposes.

Infection through parasitic Sclerotia.†—Herr J. H. Wakker has closely investigated a disease which is very destructive to hyacinth-cultures in the neighbourhood of Haarlem. It makes its appearance after the time of flowering, causing the leaves to turn yellow and fall off. No mycelium can be detected in the parts above ground, except at the very base of the leaves. The roots have often died off altogether, and the bulb is com-

* Verhandl. Zool.-bot. Gesell. Wien, xxxvii. (1887) p. 6.

† Bot. Centralbl., xxix. (1887) pp. 309-13, 342-6. Cf. this Journal, 1883, p. 686.

pletely permeated by mycelium. On its surface are black irregular sclerotia, and others in a younger softer condition. When once attacked by the disease, the plant inevitably perishes. The peziza-form will develop from the sclerotia in the course of the next spring. This very closely resembles *P. Trifoliorum*; but inasmuch as the author found it impossible to infect clover with sclerotia from the hyacinth, or the reverse, he proposes for it the distinctive name *Peziza bulborum*. In addition to *Hyacinthus orientalis*, it occurs also in species of *Scilla*, and very rarely in *Crocus*.

Germ-filaments produced from the spores in water produce sporidia, and then perish, without infecting the host; and, although it is quite possible to produce an infective mycelium from spores, the ordinary mode of infection is by the sclerotia only, the peziza-cups being comparatively rare in nature. It is very easy to produce mycelium artificially from the sclerotia, by removing the cortex or placing them in a nutrient solution; in the former case a fresh cortex is rapidly formed. By means of secondary sclerotia, produced from the primary ones, the parasite is able to maintain itself throughout an entire year almost without nutriment; and these secondary sclerotia are the chief agents in the infection.

Fluorescence of Fungus Pigment.*—According to Dr. A. Weiss, the alcoholic extracts of fungi are all more or less fluorescent. The fluorescing cone appears either green (yellow or brown fungi) or blue (red or violet fungi); but the ochre-yellow pigment of some Agaricineæ fluoresced an intense azure, the red pigment of the pileus of *Amanita muscaria* green. The spectrum of the blue fluorescing pigment of *Russula* and other fungi showed a broad black absorption-band in the yellow-green, a thin one between E and F, a total absorption of the violet to G. The band in the yellow-green coincides with the band which the spectrum of a living red peony leaf shows there, and likewise with that of the blue pigment of many species of *Campanula* after treatment with sulphuric acid. The more intense the colour of the extract, the more the absorption extends towards the red; so that with very thick layers of fluid the whole green and yellow seem extinguished. The absorptions in the violet are similar to those of the red, blue, and violet pigments of flowering plants. The green fluorescing fungus-pigments show a faint absorption-band between E and F, and a broad absorption of the violet end of the spectrum.

Pathogenic Fungi.†—Mr. J. C. Arthur continues his reports to the New York Agricultural Experimental Station. That for 1885 is devoted chiefly to the study of plant diseases. The following topics are mentioned amongst others:—

Spotting of Quince Fruit.—This is due to a fungus, *Morthiera Mespili* Fekl. var. *Cydoniæ* C. & E., always present to some extent on the leaves of the quince. On the fruit it forms circular blackish spots with a red or white margin and a dot or two at the centre.

Rotting of Tomatoes.—The disease, or diseases, causing the rotting of green fruit, and the early decay of the ripe fruit of tomatoes, seems as difficult a problem to solve after another year's observation and experiment as ever. A fungus, *Macrosporum Solani* E. & M., appeared in great quantities this year; it is often accompanied by a simple-spored fungus, *Phyllosticta Solani* E. & M., which may indeed be but a later condition of it.

Lettuce Rust.—This disease, due to a fungus, *Septoria Lactucæ* Pass., has

* SB. K. Akad. Wiss. Wien, xci. (1885) pp. 446-7.

† Rep. of Botanist to N. York Agricultural Experimental Stat., Geneva, N.Y., for 1885, Albany, 1886.

been very prevalent during both 1884 and 1885. If a plant having this disease be examined closely, both surfaces of the leaf will be found to be covered with minute brown or blackish specks, as fine as pin points, their great abundance giving the rusty colour. The vegetative threads of the fungus are not visible, being concealed in the tissues of the lettuce. It is, therefore, an endophytic species.

Lettuce Mildew.—This fungus, *Peronospora gangliiformis* dBy., first appeared in irregular patches half an inch or more across on both surfaces of lettuce leaves. The vegetative threads of the fungus grow within the leaf and only come to the surface to form spores.

Rotting of Cherries and Plums.—Von Thümen considers this fungus (*Oidium fructigenum* S. & K.) to be perhaps the most noxious and destructive of all kinds that occur upon fruit. The fungus consists of colourless, much branched and septated threads permeating the tissue of the fruit. The fruiting threads consist of short sections, each a little more swollen as they approach the ends of the threads where the sections are elliptical.

Disease of Clover-leaf Weevil.—In the latter part of May, great numbers of pale-green larvæ, nearly an inch long, were found clinging to the grass and clover of the meadows, apparently dying from the attack of some fungus. Dissecting a sick larva before death has occurred, a close network of fungoid threads will be found among the muscles which line the wall of the body. They are profusely branched, colourless, without septa, the contents finely granular, and with or without vacuoles, or clear spots, of variable size. This mycelium grows rapidly, and soon encroaches upon the body-cavity of the insect, encompasses the various organs, finally absorbing the juices and filling up the body with a solid mass of the fungus. The spores are formed at the end of each mycelial branch; some of the branches, however, are enlarged and sterile. The spores are oblong, rounded at both ends, one-celled, with thin walls and colourless granular contents, and are comparatively large. The fungus is *Entomophthora Phyttonomi* Arth.

In his Report for 1886, Mr. Arthur* deals further with the question of plant diseases. The following is the order of topics:—

Rotting of Tomatoes.—Another year of observation on tomatoes strengthens the opinion that the rotting of the fruit is not brought about by a single agency, but by several, sometimes combined, but more usually acting independently. The objects of the note are to point out that the soft rot, chiefly affecting ripe fruit, must be discriminated from the brown or black rot affecting green fruit. Probably Dr. Halsted is correct in referring the decay in green fruit to *Cladosporium fulvum*.

Disease of Clover-leaf Weevil.—Further study of *Entomophthora Phyttonomi* Arth. reveals the fact that when the spores are germinated upon the surface of water they take on a different development. Instead of at once producing mycelium, they send out a short slender pedicel from one side, which bears a solitary minute spore. The minuteness of these secondary spores, and their aerial formation, makes it evident that they serve for long distance transportation by wind.

Strauberry Mildew.—This fungus, *Sphærotheca Castagnei* Lev., produces a delicate white cobwebby growth, which overspreads the plant attacked. Later in the season, the resting or winter spores are formed in minute globular spore-cases, which are first yellow, then change to black as they ripen.

* Rep. of Botanist to N. York Agricultural Experimental Stat., Geneva, N.Y., for 1886, New York, 1887.

Plum-leaf Fungus.—This fungus, *Septoria cerasina* Pk., first becomes conspicuous to a careful observer about the middle of July. It starts at isolated points on the leaf-blades, apparently from spores derived from the air, and spreads into a circumscribed area, usually not exceeding one-eighth of an inch in diameter, and more commonly but half that size. The spots are usually more or less rounded, but may be angular when bounded by veins. The fungus produces three sets of spores at different seasons of the year; the septoria-spores in summer, the phoma-spores in winter, and the ascospores in spring. It is reasonable to suppose that the three sorts of spores have three diverse and important offices to perform. As to the ascospores, they germinate upon the leaves of the plum-tree in spring, and start the new growth that some time afterward bears the septoria-spores. The phoma or winter spores may be of sexual nature, and perform the office of the male element in originating the ascophorous stage of development.

New Genus of Ascomycetes.*—Herr H. Zukal describes the new genus *Baculospora* with the following characters:—No stroma; mycelium very transient, and feebly developed. Perithecia half imbedded, membranous, pellucidly yellow. Asci club-shaped, apiculate, with greatly thickened wall, and eight cylindrical brown ascospores. The only species, *B. pellucida*, was found on horse-dung.

Ancylisteeæ and Chytridiaceæ.†—Pursuing his investigations on these groups of fungi, Herr W. Zopf finds that a convenient mode of culture is on pollen-grains in water. He was in this way able to follow out the life-histories of *Lagenidium pygmæum* and *Rhizophidium Pollinis-Pini*. The germinating tube of the swarmspore readily penetrates the membrane of the pollen-grain, and develops into a spherical, ovoid, or kidney-shaped bladder, which is transformed into a sporangium, within which swarmspores are again formed. After some days the sexual organs are also produced. An undescribed species of *Rhizophidium* he finds parasitic on a diatom, *Cyclotella operculata*, which puts out its mycelial tube between the valve and the girdle-band, thus penetrating into the cell. Another new species, *R. sphærotheca*, attacks the microspores of *Isoetes lacustris*, producing in them a fatty degeneration.

Mycorrhiza.—Herr B. Stein ‡ confirms the observations of Frank on the occurrence of a symbiotic fungus on the roots of trees, and enumerates a large number of species in which he finds its presence to be constant. He regards the fungus as playing a most important part in supplying nutriment to the trees on which it grows.

M. F. Kamiński § believes that true symbiosis of a fungus-mycelium with a root is not so common a phenomenon as Frank supposes. In the case of *Carpinus Betulus* he finds that the fungus which clothes the roots has a distinctly prejudicial influence upon them, causing hypertrophy of the tissue, and in that of *Pinus sylvestris* abnormal dichotomous branching and resinosity in the vascular bundles of the roots. *Monotropa hypopitys*, on the contrary, furnishes an example of true mycorrhiza, the fungus being found on the surface of the root, not as a parasite, exercising no injurious influence, and carrying nutriment to the root.

* Verhandl. Zool.-bot. Gesell. Wien, xxxvii. (1887) pp. 39–40 (1 pl.).

† Ber. Naturf. Gesell. Halle, 1886, pp. 31–7. Cf. this Journal, ante, p. 283.

‡ JB. Schles. Gesell. vaterl. Cultur, lxiii. (1886) pp. 409–12. Cf. this Journal, 1886, p. 113.

§ Arbeit. St. Petersburg Naturf. Gesell., xvii. (1886) pp. 34–6. See Bot. Centralbl., xxx. (1887) p. 2. Cf. this Journal, 1886, p. 113.

Green colour of decaying wood.*—Herr H. Zukal has carefully examined the green colouring matter of *Peziza Jungermanniæ* and *P. æruginosa*, both of which are frequently found on decaying wood. He finds the pigment of the two species to behave the same with various reagents, and that it can pass out of the mycelium into the adjacent wood. This is probably the cause of the green colour often seen in rotten wood.

Protophyta.

Chemical constituents of Bacteria.†—Herr L. Vincenzi gives details of experiments relating to *Bacillus subtilis*. A pure culture was obtained by Roberts's method. The fluid containing them was filtered through asbestos, the bacteria remaining on the filter were washed with water and 0·5 per cent. sodium hydroxide solution, digested with artificial gastric juice for twenty-four hours, washed free from peptones; finally, they were washed with alcohol and ether and dried. In the cell-wall, which was all that remained after this treatment, no cellulose was found; but it was nitrogenous, yielding from 5·3 to 11·15 per cent. of nitrogen in different specimens, the amount seeming to depend on the different stages of growth of the bacteria. No opinion is expressed as to the nature of this nitrogenous substance.

New Species of Spirillum.‡—Prof. N. Sorokin found in the hollow stem of an old and rotting poplar a whitish foul-smelling fluid. The white colour was found to be due to crowds of a very motile *Spirillum*. No other microbes were present, so that there was quite a pure cultivation. The contents of the *Spirillum* were transparent, granules in the protoplasm not being observed. Multiplication took place by simple division. Occasionally the micro-organisms were collected into not very large zooglœæ.

Among the forms which rapidly flitted across the field of vision, there were some which were either quite immobile, or at most turned from one side to the other. In these, spores could be perceived. Their diameter was less than that of the parent cell, and their number greater according as the organism was longer. The reproduction-organs germinated in the parent cell. The germs developed into rodlets, which in fifteen to twenty minutes began to twist and separate. The young *Spirillum* had usually two turns, the adult not more than three. The curvature might be more or less marked. As the young *Spirilla* did not always separate from the parent cell, large specimens were frequently seen still attached to the parent *Spirillum*, so that a branched form was produced. It is noteworthy that the spores, so long as they remain within the parent cell, possess no cell-wall, and present only a small collection of minute granules. From this characteristic development, the author has called this organism *Spirillum endoparagogenicum*.

New Micro-organisms obtained from Air.§—Messrs. G. C. and P. F. Frankland have cultivated a number of organisms from the atmosphere, and have studied their distinctive characters; a list is given, among which are five *Micrococci*, ten *Bacilli*, and two *Saccharomyces*.

Distribution of Micro-organisms in the Air.||—Since the last report on the subject by Dr. P. F. Frankland,¶ he and Mr. T. G. Hart have made

* Oesterr. Bot. Zeitschr., xxxvii. (1887) pp. 41-6.

† Zeit. Physiol. Chem., ii. pp. 181-3. See Journ. Chem. Soc. Lond., Abstr. 1887, p. 393.

‡ Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 465-6 (1 fig.).

§ Proc. Roy. Soc. Lond., xlii. (1887) pp. 150-1.

¶ Ibid., p. 268-82.

¶ See this Journal, ante, p. 453.

further experiments with Hesse's tubes, both on the roof of the Science Schools and in the interior of buildings.

To obviate the melting of the tubes in hot weather they were wrapped in bibulous paper saturated with water, and this was surrounded by tissue paper.

In the open air the number of micro-organisms increases with the temperature; thus in January, with temperature of $3\cdot5^{\circ}\text{C}$., only four colonies (average) per 10 litres of air were obtained, whilst in August, temperature $18\cdot3^{\circ}$, as many as 105 colonies were found.

In the interior of buildings the same result as in the previous communication was arrived at, viz. that micro-organisms are more numerous when the air is disturbed than when no movement is going on.

A table of results and a table of curves formulating the results conclude the paper.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Jaubert's Microscopes, Eye-pieces, Objectives, &c. — One of the most extraordinary patents on the file of the Patent Office† is certainly that of M. Leon Jaubert for "Improvements in Optical Instruments." Five large sheets, 27 by 19 inches, are filled with 189 figs., 125 of which illustrate his ideas of improvements in both Monocular and Binocular Microscopes and describe objectives and eye-pieces of special arrangement made of concentric layers of glass united in groups, multiple objectives, revolvers for eye-pieces and objectives, a rotary micrometer, prisms, and other similar matters. We have selected the following as sufficiently showing the patentee's views, and if more information is desired the specification of the patent is available in the Library.

Universal Microscope. — This is copiously illustrated in all its parts in the Specification, but we give in preference (fig. 155) a modern form of the Microscope, as actually constructed by the patentee and recently exhibited by him. It has an oval base S, supporting two pillars C, which are bent towards each other at the upper ends, so that the trunnion or inclining axis ϕ is much smaller than usual; a spring-catch f engages in a series of holes in the socket A of this axis to fix the various positions of inclination. A second axis is applied in front of A to provide lateral inclination of the stem B, carrying the arm B', the body-tube T, the stage P, the mirror G, &c.; a spring-catch r fixes the position by means of a series of holes shown on the collar. The stem B has a rack on either side on which acts a screw-collar E, raising or lowering it in the socket A'. A similar mechanism is applied to the body-tube for the coarse-adjustment actuated by the screw-collar E¹ with a slow movement by the screw-collar E³. A third screw-collar at E² focuses the micrometer in the eye-piece. The fine-adjustment has two rates of motion by the milled heads V and V¹. The substage H is provided with a fine-adjustment actuated by the screw-collar e².

We have not attempted to give the full description of the patentee, but

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photo-micrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† 1866, No. 473, 14th February. Cf. also *Les Sciences*, i. (1883) pp. 55-7 (3 figs.), and pp. 9, 11, 31, 46, 62-3, 78, and 109.

the general features of the construction are sufficiently obvious from the foregoing. The main speciality of the instrument consists in the two axes,

FIG. 155.

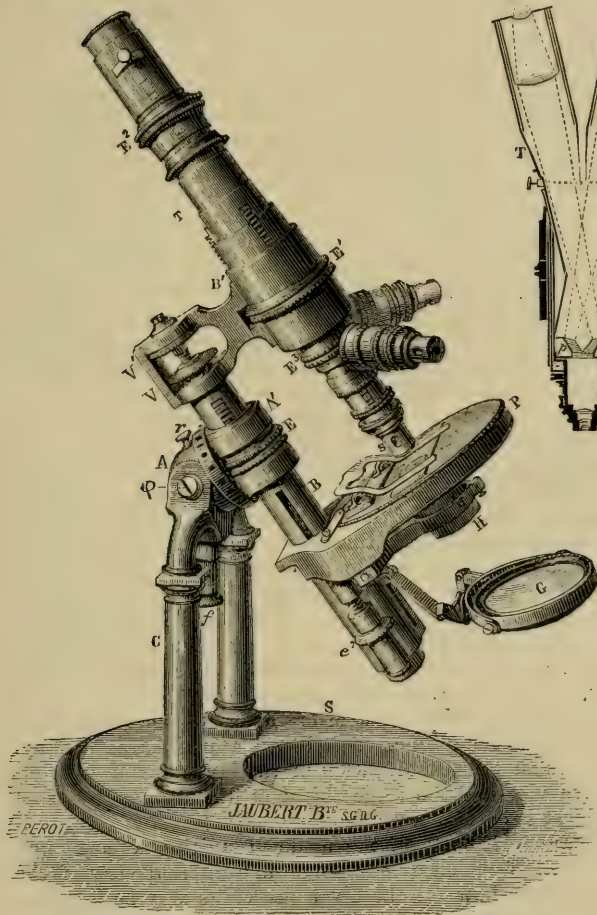
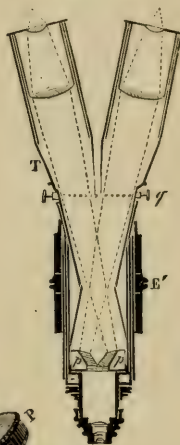


FIG. 156.



so that it can be placed in any position, vertical, horizontal, inclined, "reversed vertical" for chemical purposes, and laterally oblique.

Figs. are given in the specification representing the Microscope converted into a chemical, photographic, and solar Microscope.

Binocular Microscopes.—Of these, several different forms are described.

Fig. 156 "represents a binocular Microscope, with a mode of producing a variable separation of the tubes, and having a single object-glass; adjustment of the focus is effected by means of the screw collar *E'*. The tubes *T* are after crossing again united at their lower extremities by two hinges, and may be separated at their upper extremity by means of the reversely threaded screw at *q*. The two prisms *p p* which divide the rays coming from

the object-glass follow the motion of the tubes upon their hinges. One of the two prisms is placed a little higher than the other, in order that the rays may not pass between their angles, which may in this manner cross each other more or less."

Fig. 1, plate XII., represents a front view of another binocular Microscope. The variable separation of the tubes t, t , as well as their drawing motion, take place by means of the milled head E^1 , and by the pinions i taking into racks fixed upon each of the interior tubes. The prism p^1 , which is conical, circular, concave, and truncated, reverses the image by causing the rays to pass to the left which it has received from the right, and those to pass to the right which it has received from the left.

Figs. 2, 3, and 4 "show other arrangements of prisms or reflectors either plane or curved, the object of which is to divide into two parts the rays coming from an object-glass of any kind, and to render them binocular; this arrangement allows of the visual angle being preserved and the angle of the two eye-tubes being equalized. Although two of the prisms or reflectors are not placed in the same plane, they have nevertheless no influence upon the extent of the luminous rays and the dimension of the rays which pass through them. A reverse threaded screw allows of the prisms p, p^1 , being separated, and another similar screw serves also to move the prisms p, p , into the positions shown at fig. 5, and which then furnish images of another kind. With reflectors formed by a sector of a cylinder (fig. 4) images" different from the preceding are obtained, and present singular effects, "which with their applications form part of this invention."

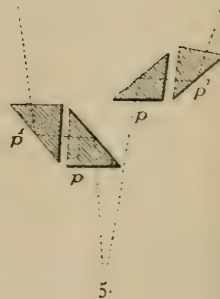
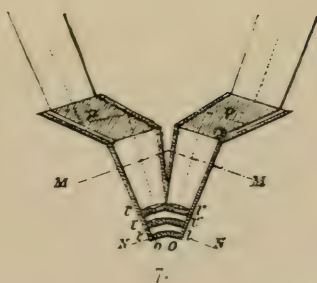
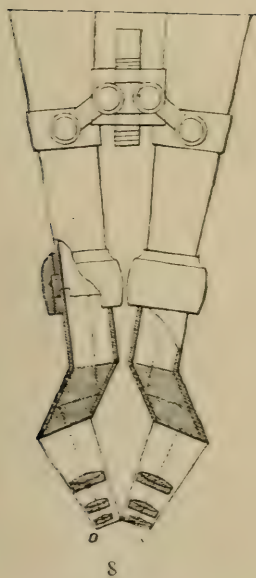
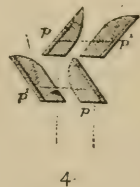
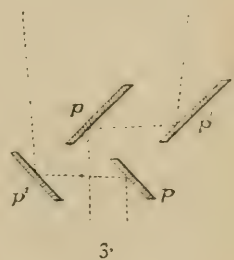
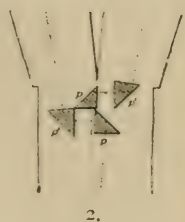
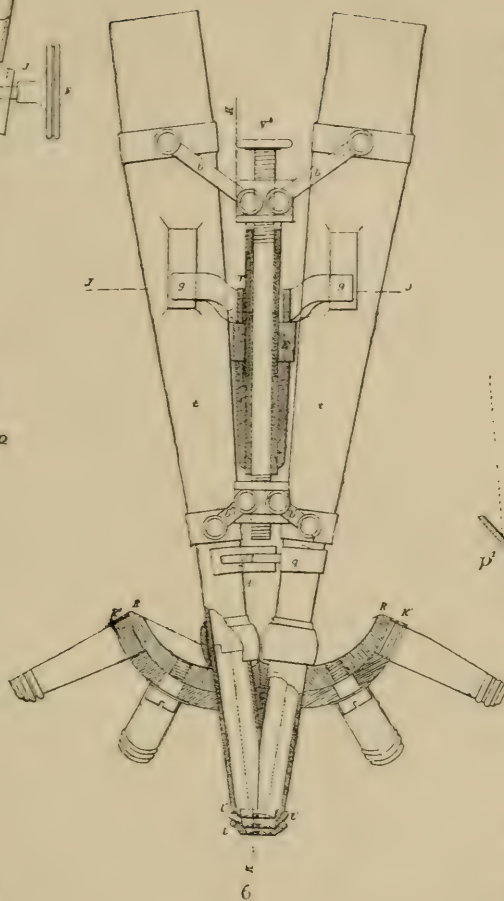
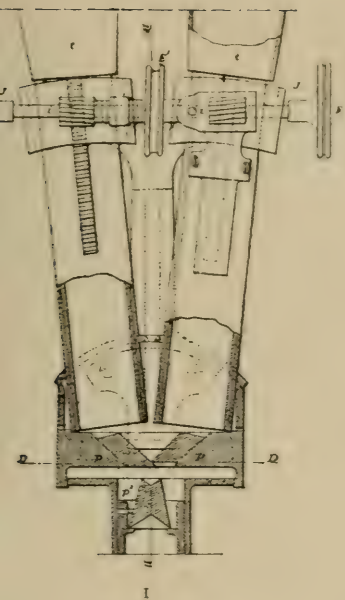
Fig. 6 represents a binocular Microscope with double object-glasses. "The two tubes are made to suit the variable distance of the eyes of the observer by turning the head of the long screw V^3 , which acts by means of two different proportioned screw threads upon the arms b, b, b^1, b^1 , so that the tubes t, t , can be made to recede from each other until the arms b, b^1 , are parallel in two planes passing through their points of attachment, without the object leaving the focus. Each tube is furnished with revolving object-glass holders having three or four object-glasses; this might also be the case with the eye-pieces." The tubes of the object-glasses are cut away when their focus is very short.

Fig. 7 represents a portion of a Microscope for two persons to inspect the same object at the same time. The lenses are slightly cut away.

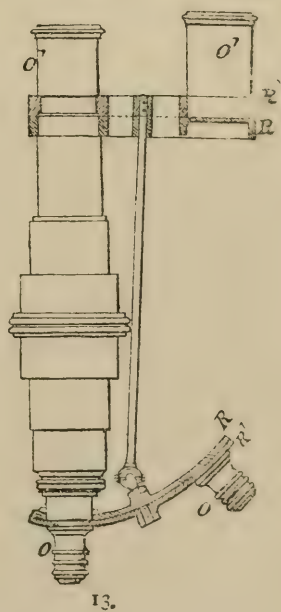
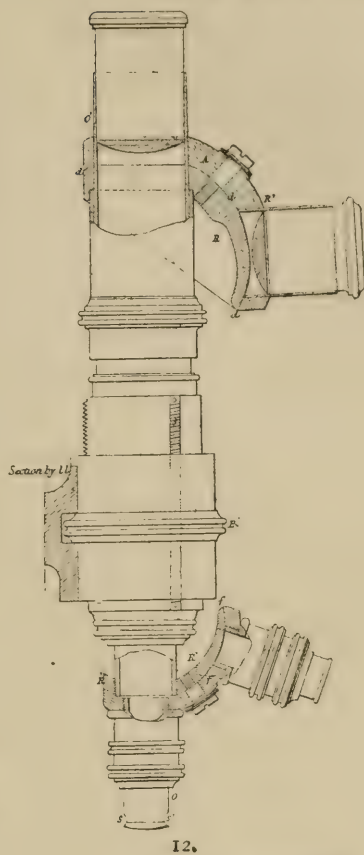
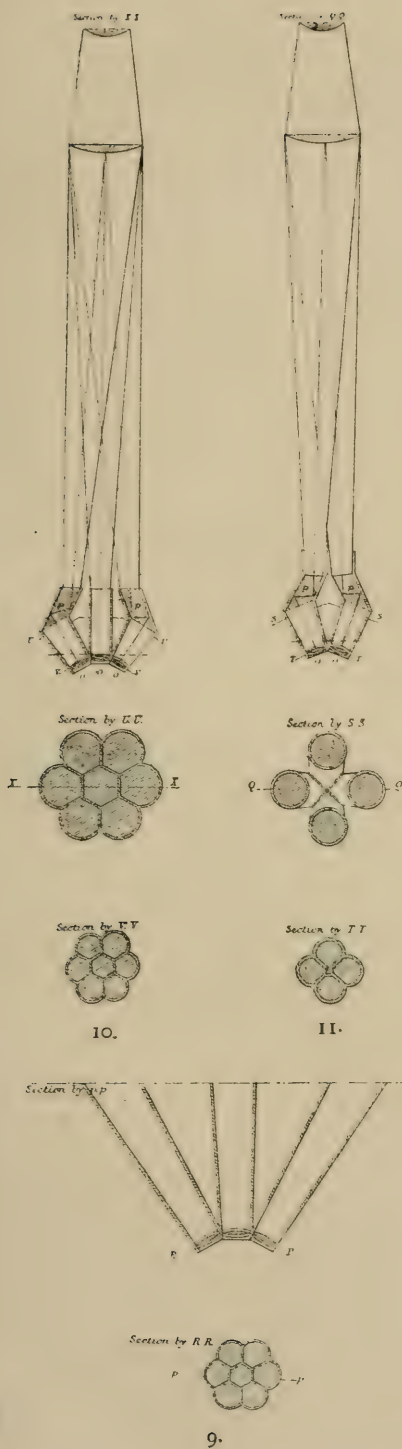
"Fig. 8 shows another modification of the binocular Microscope and is intended to give views of the same object at different angles, so that the relief of the object is considerably augmented."

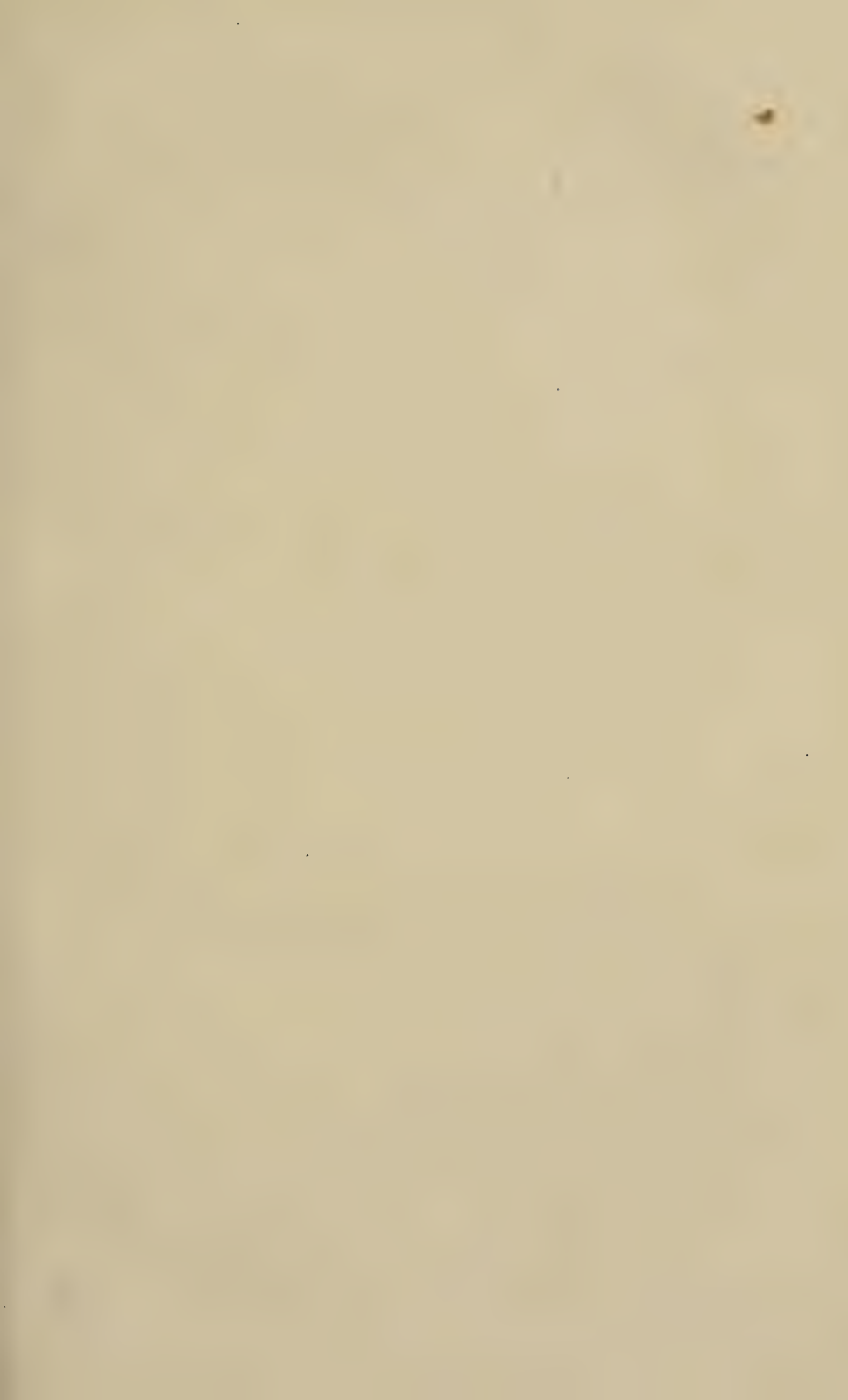
"Fig. 9 (plate XIII.) shows the mode of uniting a large number of object-glasses, each of which gives a somewhat different view of the object. Figs. 10 and 11 show how all these various views may be brought to bear upon the same eye-piece or upon the same point, or upon different points. These object-glasses may be made all to magnify to the same or to different extents."

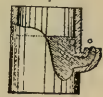
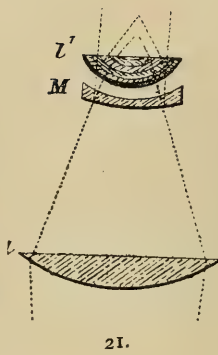
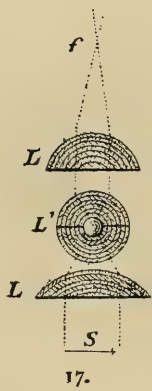
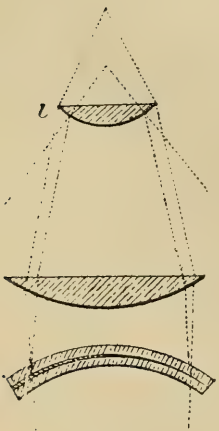
"These binocular Microscopes having one or more object-glasses, or having several object-glasses and one eye-piece, are also intended for photographing objects, and for reproducing them with forms and reliefs resulting from these arrangements. These views may be superposed completely or partially, and be of equal or different dimensions, or different views of the same object, but of such dimensions that those which reproduce the same plans shall be larger or of greater magnifying power, and the others smaller, or *vice versa*. They may be combined in such a manner as to reproduce with incomparable perspective and fidelity the object, scene, or landscape photographed or under view, and so that



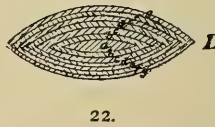
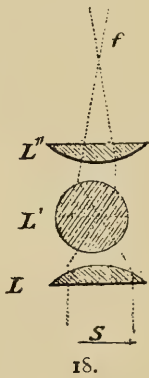
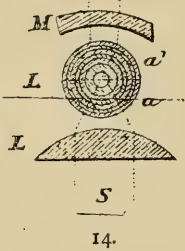
Jaubert's Microscopes, &c.



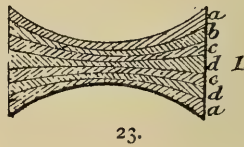
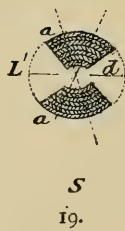
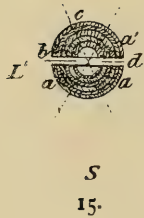




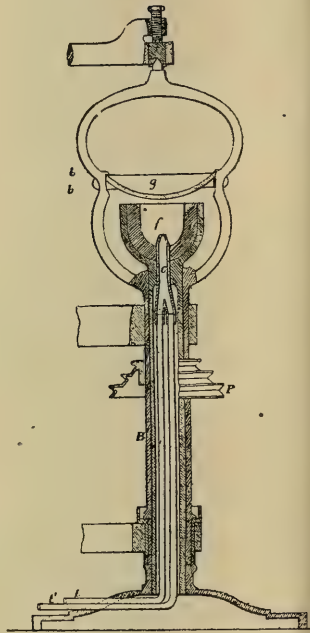
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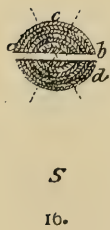
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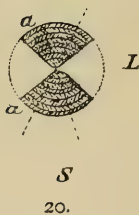
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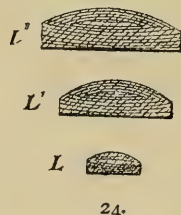
26



16.



20.



24.



27.

plane images drawn upon paper shall appear to be in relief as if looked at through a stereoscope."

Hand Binocular magnifying glasses are also described and illustrated.

Objectives and Eye-pieces.—In the settings there are several peculiarities. "Two openings, s s' (fig. 12 of plate and fig. 155), made in the outer tube of the objective, allow of the entrance of the light condensed by prisms, mirrors, or reflectors upon an opaque object even with the employment of the greatest magnifying power, even with glasses where the system of immersion is employed. Each of these openings is furnished with a small thin tube of silver or copper in order to prevent the dust from entering between the first and second lenses. This light may be polarized by means of a prism made of Iceland spar or any other polarizer, and coloured or monochromatized by a lens or plate of rock crystal."

Both objectives and eye-pieces are mounted on revolving holders f , with spherical bars R and R' , as shown at fig. 12. The revolving holders may be connected together by a rod, fig. 13, so that the eye-pieces and objectives may be changed simultaneously.

The "optical part" is, however, the most curious of the patentee's suggestions (figs 14–24, plate XIV.). "It is composed of lenses or series of lenses, the arrangement, form, and composition of which are special. The first lens is plano-convex; the second, which may be composed of two parts, is a complete ellipsoid, or formed of two parts of ellipsoid, or hyperboloid, or paraboloid, or even simply a spheroid. In certain cases it may be divided into two parts (fig. 15) plane or cut out at their centre, with such a curve (fig. 16) that the rays which come from the object S shall arrive at the face d , leave it, and after crossing each other shall penetrate the face b , and emerge from the face c after a fresh refraction, which shall render them sensibly parallel. They are rendered divergent by the periscopic lens M , fig. 14. If this lens is replaced by another which is plano-convex or a divergent periscopic meniscus (figs. 17 and 18), the rays will cross each other again at f , and the image will be again turned round. The lens, instead of having its centre cut out, may have it formed of a lump thicker than the rest; it may also be cut or shaped as seen at figs. 19 and 20. The lenses may be neither complete ellipsoids nor hyperboloids, and may be set at variable distances (figs. 16, 19, and 20). The lenses L , L' , are shown on a scale larger than the real size. This arrangement of object-glass is applied in all its variations to all optical apparatus to which it may be applicable, especially to photographic apparatus, as well to simple as to compound ones, which will be hereafter alluded to."

"The improved eye-piece is composed of a convergent periscopic or non-periscopic meniscus, placed as shown at fig. 14, and of an ordinary eye-piece. Fig. 21 represents an eye-piece in which the divergent periscopic or non-periscopic glass is placed near the eye-piece."

"All the improved lenses are composed of glass in simple concentric layers, or in groups laid one upon the other and rendered adherent or fastened together, and arranged under conditions of thickness, arrangement, curvature, dimensions, and powers of refraction and dispersion even variable from the centre to the edge, such that not only are they completely achromatic, but moreover, whatever may be their form, even spherical, they may be completely deprived of spherical aberration, chromatic aberration, astigmatism, and distortion, and give the chemical focus at the same mathematical point as the optical focus. These layers, either coloured or not, are applied to the glasses of all optical instruments, spectacles, eye-glasses, field-glasses, and telescopes, and not only will these superposed

layers of analogous form and arrangement serve in certain cases like that of the animal crystalline lens, and in other cases simply superposed serving for the production of complete achromatism, but also under certain circumstances arranged in a manner contrary to the preceding arrangements they will serve to produce the maximum of chromatism and the separation of the chemical focus or optical focus, or even of the entire or partial spectrum or the neutral tints, &c., for the production of the effects of polarization and interference."

"Fig. 22 represents a double convex lens formed of concentric layers, the chemical and optic foci of which meet at the same point without aberration of any kind. Fig. 23 is a double concave of the same arrangement. Fig. 24 represents an object-glass composed of a series of three lenses achromatized by concentric layers superposed, and in the form of an ellipsoid, hyperboloid, or paraboloid, or simply a spheroid."

Making the Lenses.—Although somewhat lengthy, we transcribe this part of the patent in full, as it is by far the most "original" portion of the patentee's description. "In order to make the small Microscope lenses, especially for the first or object-glasses as well as the eye-glasses of the others, liquid glass is placed in a small pot or crucible formed as shown in fig. 25. The vitreous matter is passed through a small opening *o*, and by means of a blower it is blown in a state of fusion; by this means it is granulated or divided into round granules, the size of which is in proportion to the size of the opening *o* and of the blower, and to the force with which the air or gas is projected through the fused material. Instead of air or gas high-pressure and superheated steam may be employed, or a stream of water or other liquid at a high pressure and at a suitable temperature. If these granules should be required to be slightly flattened on one side a plate of metal or glass is placed in front and perpendicularly or obliquely to the plane of projection; they are then collected in hot water or any other non-inflammable liquid, or in any other manner, and annealed or fired if need be, and achromatized in the manner hereafter to be described; there may be any number of openings *o* and also of blowers that may be thought desirable.

"The following are the processes for manufacturing the improved lenses with concentric layers having variable refractive and dispersive powers from the centre to the edges, and which process is applicable to the manufacture of lenses of any form and dimensions, spherical, parabolic, elliptical, and hyperbolic, concave, or convex. By means of the apparatus represented at fig. 26 the form and thickness of the lenses from the centre to the edge and their curves may be varied at pleasure according to the degree of density or liquidity of the glass. This apparatus is composed, first, of a hollow fixed foot carrying the bell-shaped vessel made of fire-brick, and having openings for the pipes *t*, *t'*, into its interior for conducting hydrogen or other gas and condensed air into the blow-pipe *c*, at the orifice of which they are ignited; second, of a shaft *B*, which may be driven at a rapid speed by means of the pulley *P* in communication with friction gearing; it carries a capsule or cup *g*, made of platinum or fire-clay. This cup may be either concave, as in fig. 26, or convex, or of any other form, according to the form of lens required to be produced. A drop or lump of liquid glass is to be placed upon the cup *g*, the apparatus is set in motion, and when one layer has received the required form the fire is moderated and the apparatus stopped, and the second layer of liquid glass of the same or of different density is laid thereon, and the operation is continued as before, and so on until the lens has been brought to the required form, thickness, and density. The various vitreous matters in

fusion may be taken from the pots (placed in the furnace for that purpose) with a platinum brush, the handle of which is hollow, and through which ignited air and gases are caused to pass into the wires of the brush, so that the matter being kept at the required temperature has not time to solidify, and may be laid upon the lens placed upon the preceding apparatus, when stationary, in the same manner as a layer of any other substance, such as paint, would be laid on. Plates of suitable thickness and forms in crown and flint glasses may also be prepared by blowing and moulding, as hereafter described, and caused to adhere together; for this purpose the arrangement of tubes t , t' (fig. 26) is employed, fed by air and hydrogen gas or any other combustible giving a flat fan-shaped flame. Pincers having two or three jaws are held in each hand for the purpose of holding the plates to be united; when the faces to be united have been softened they are brought in contact through the flame, the pincers being continually kept turning. In the case of periscopic convex plates, the one which is to take the form of the other must be softened on both faces. The handles of the pincers and also that of the platinum brush have a tube like that of the blow-pipe c for the passage of air and gas which passes through them, the flame impinging upon the back of each plate at the same time that the flame of the intermediate burner impinges upon the two faces; this arrangement allows of one of the plates being sufficiently softened to take the form of the other.

“If the plates are of somewhat large dimensions the pincers are mounted upon a lathe to the mandrils of which a rotary motion of greater or less speed is imparted, and also a reciprocating motion. One of these shafts may advance one of these two plates upon the other; seams and inequalities are caused to disappear by the softening of the glass combined with the motion, but if the lenses to be produced are of large dimensions the preceding processes might be partly insufficient, and in that case plates are employed of the dimensions, forms, thickness, and refractive and dispersive powers suitable for the effect desired to be obtained. They are laid over one another one by one, and set in a mould of polished clay which is introduced into an annealing oven and left there until the plates all adhere. If the lens is to be of any other form than plano-convex the mould has a heavy cover glazed inside, which bearing upon the lens, imparts to it the form (either convex or concave) which it has itself. A greater or less degree of pressure may be employed in order to expedite the adherence and increase the density. If, seeing the various kinds of glass (crown and flint) employed fluid or in plates, and seeing the curves of the lens and the length of focus which might be required, achromatic lenses free from aberrations of any kind could not be obtained, groups might be employed formed of layers superposed and afterwards united as simple plates. If required, fluxes might be interposed between the plates or upon the exterior surfaces of the lenses with the platinum brush. These fluxes may be composed as follows:—One part of white sand, three parts of minium, 0.5 of calcined borax, or three parts of white sand, one part of minium, and five parts of calcined borax, or others, according to the effect desired to be obtained. Instead of these fluxes pulverized glass (either flint or crown) is employed especially upon exterior plates, by means of the fan-shaped burner; this powder is brought into a state of fusion, and the required form is given to it by a suitable movement. Bevelled plates which are partially superposed, or concentric circles and plates, the bevels of which overlap, may be employed, so that the index of refraction shall vary from the centre to the edge. Instead of these circles or plates, or concurrently with them, annular parcels or fagots of glass

threads of flint or crown glass of various densities are placed concentrically one in the other, and superposed or not at their extremities. These circles or parcels of threads are made of any thickness; the threads of glass may also be placed vertically.

"The refraction and dispersive power is also caused to vary in lenses, the density of which is variable from the centre to the edge, by placing tubes formed of glass of different densities, as flint and crown glass, figs. 27, *a, b, c, d, e*, one inside the other, which are softened by heating and again blown. Other tubes of greater density *f, g, h, i*, are placed inside them, softened, and again blown. Tubes *j, k, l* are again put in until the whole and the centre are well filled, they are again softened and drawn, and a cylinder is obtained. If drawn with sufficient rapidity the whole of the concentric cylinders will only form a single cylinder of greater or less thickness, or if the cylinders interposed are sufficiently numerous, a convex lens cut from this cylinder will be deprived of spherical aberration and even of chromatic aberration if the density augments from the edge to the centre, if concave it will be also deprived of aberration, if the density augments from the centre to the edge. These tubes, brought at their extremity to the point of fusion, may be blown, and Microscope lenses will be formed that will be in concentric layers and will be achromatic and without aberration. By bringing them to the point of fusion lenses may in this manner be produced, the outer layers of which will be less dense and have the form and arrangement of layers analogous to those of the crystalline lens of the human eye and will be achromatic.

"Under certain circumstances concurrently with the plates, circles, bundles, and fluxes, silicates in solution in hydrochloric acid or hydrofluoric acid may be employed diluted with water or combined with other transparent substances either to cause the plates to adhere together or to obtain the required degree of refraction or dispersion. Intermediate layers of crystallized boron, sesquichloride of carbon, crystallized or melted silicic acid,

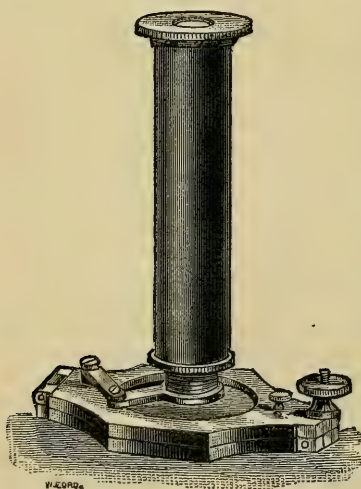
bichloride of tin, small crystals, and even powder of any kind, principally powdered glass, either colourless or of many colours, obtained by the method of granulation above described, are applied by means of heat and pressure, currents of electricity, and other mechanical and chemical forces aided by blowing, moulding, and motion. By these means all the required forms and qualities are obtained, so that the refrangibility, dispersion, transparence, malleability, density, hardness, and elasticity of these lenses may be varied."

Amongst other matters dealt with are a screw guide for sliding tubes, adjusting screws with differential threads for slow or rapid motion, a universal joint to foot with clamp, improved stages, &c.

Bausch and Lomb Optical Co's Trichinoscope.—Another form of this

instrument (described Vol. II., 1882, p. 258) is shown in fig. 157, the doublet being replaced by a compound Microscope which is combined with the compressor (described Vol. III., 1885, p. 714).

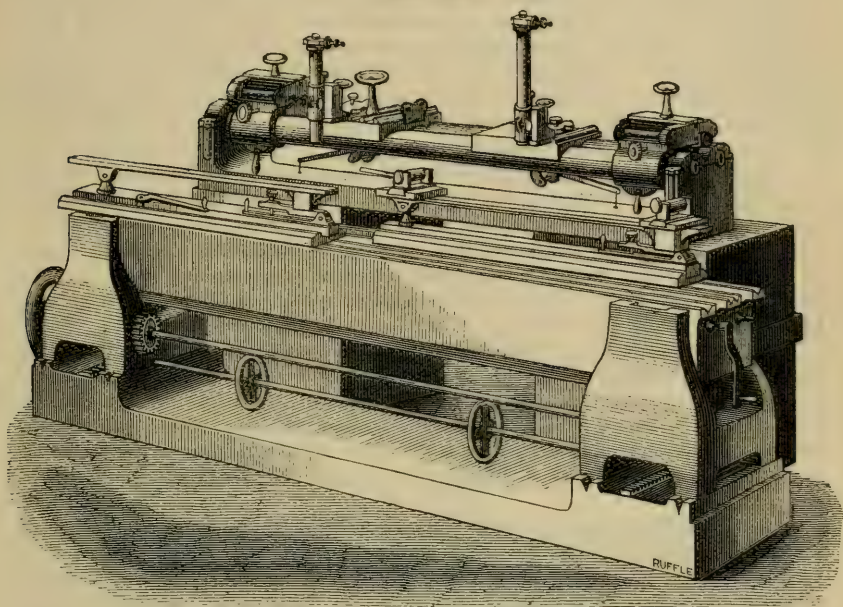
Fig. 157.



The original form with the doublet is on the whole decidedly preferable, and forms a convenient pocket Microscope for field use in collecting Infusoria, algæ, &c.

Rogers-Bond Universal Comparator.*—The special features of the Universal Comparator (fig. 158), devised by Prof. W. A. Rogers and Mr. G. M. Bond, are, as its name implies, the variety of the methods employed and the range of work that can be done in comparing standards of length; each independent method, when carefully carried out, producing similar

FIG. 158.



results which serve to check or prove the comparisons. It includes a method for investigating the subdivisions of the standard by comparing each part of the total length with a constant distance, determined by two adjustable stops.

A heavy cast-iron base is mounted upon stone-capped brick piers, giving a permanent foundation to the apparatus. Upon this base, and reaching from end to end, are two heavy steel tubes 3 in. in diameter, ground perfectly straight, and made "true" by a system of local corrections after they are firmly secured upon the bed-plate of the machine, the object being to get a straight-line motion of the Microscope plate, which slides freely on these true cylinders. Flexure of these cylindrical guides is provided for, by lever supports at the neutral points. Fitted closely to these guides, and outside of the range of motion of the Microscope plate, are two stops, one at each end, as shown in the figure. The stops are arranged to be adjusted at any desired position along the guides, and are

* Description supplied by Prof. Rogers. Cf. also Proc. Amer. Acad. Arts. and Sci., xviii. (1882-3) pp. 287-398 (7 figs.). Journ. Franklin Inst., cxvii. (1884) pp. 361-5 (2 figs.).

securely held by clamping on the under side. These stops are each provided with a pair of electro-magnets, the poles of which do not come in contact with the armature seen at either end of the Microscope plate. The magnets are intended to overcome the unequal pressure due to ordinary contact, a rack and pinion being used to move the plate. The magnets are used to lock the Microscope plate at each end of its traverse between the stops.

Beyond the main base just described, and supported also on brick piers, is an auxiliary cast-iron frame, which is provided with lateral and vertical motion within limits of zero, and 8 in. and 10 in. respectively, for rough or approximate adjustment, and upon the top of this frame are two carriages, which slide from end to end, a distance of about 40 in. Upon these sliding carriages are placed tables provided with means of minute adjustment, for motion lengthwise, sidewise, and for levelling, thus permitting the adjustment of a standard yard bar quickly, and without the necessity of its being touched with the hands after being placed upon the table until the work of comparison is completed.

The tubes of the Microscopes are 12 in. long and $1\frac{1}{4}$ in. diameter with eye-piece micrometers, and the objectives are fitted with Tolles's illuminating prism just above the lower lens.

This method of illumination has proved to be invaluable in the work of comparing line measure standards, especially so in the case of bars having lines ruled on polished gold surfaces at the bottom of wells sunk one-half the depth of the bar.

The first operation in the use of the comparator is to level the main base; then sliding the Microscope plate from end to end of the steel tubular guides—having the Microscope adjusted so as to be in focus upon the surface of the mercury held in a shallow trough, over which the Microscope passes—the curvature due to flexure of the guides is determined, and may be compensated for by counterweights at the various points of support.

In order to test this right-line path of the Microscope plate, the following method is employed. A fine line is traced upon the plane surface of a standard bar, extending throughout its entire length. This is accomplished by means of a cutting-tool attached to the Microscope carriage. Then, reversing the position of the bar, a second line is traced near the first, care being taken to have the distance between the two lines of each end a constant quantity. If the distance between the lines is a constant at every point, it is safe to assume that the horizontal curvature is insensible.

The extent of the effect of any horizontal curvature in the cylindrical ways may also be found by comparing the lengths of two standards placed at varying distances from the centre line between the ways.

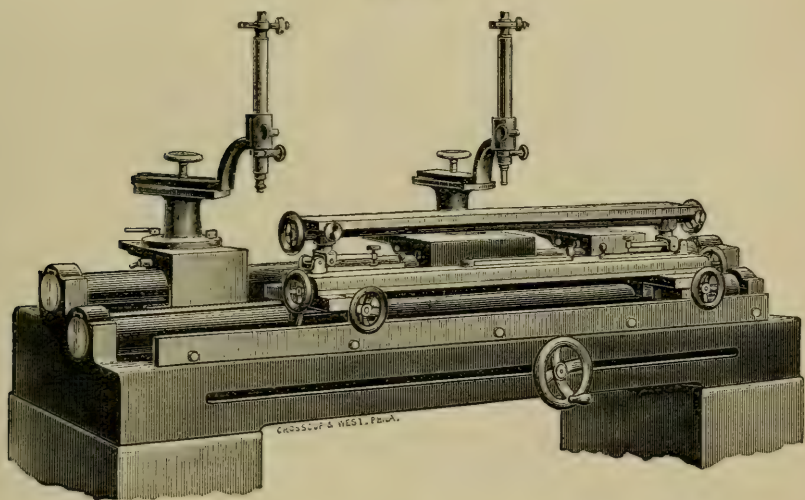
While the comparator has all the conveniences belonging to the ordinary method of comparisons by means of two Microscopes, preference is given to the "stop method." The adjustable "stop plates" are first set approximately at a distance apart equal to the lengths of the standards to be compared. The Microscope plate having been brought into contact with the left stop, the reading of the micrometer is made for coincidence with the initial line of the standard. The carriage is then placed in contact with the second stop and the reading for coincidence with the terminal line is then taken. The bar to be compared now takes the place of the standard, and micrometer readings are made as before. The difference between the results of these micrometer readings gives the difference between the lengths

of the two standards, since the distance between the stops may be considered constant for the short interval of time required to make the comparisons. It is the experience of Prof. Rogers that the precision of the contacts is about four times as great as that of making coincidences between a line of the scale and the micrometer line of the Microscope. The experiment of making one hundred successive contacts and coincidences has been frequently made without observing a single instance in which a variation from constancy under a $1/4$ objective could be detected.

In the employment of the "two Microscope method," the comparator has a convenient auxiliary attachment for observing the graduations when the graduated surface is in a vertical plane, according to the method first used by Lane of the U.S. Coast Survey.

A modification of this form of comparator, made by the Ballou Manufacturing Company, of Hartford, Conn., from the plans of Prof. Rogers, for Prof. Anthony, of Cornell University, is shown in fig. 159. The instrument is mounted upon a single heavy base. Though not having the range of motion in the adjustable supports for the standard bars possible with the original comparator, it possesses all of the conveniences for rapid adjustment and accuracy of movement. The right line motion of all moving parts longitudinally is governed by heavy cylindrical guides, and the same

FIG. 159.

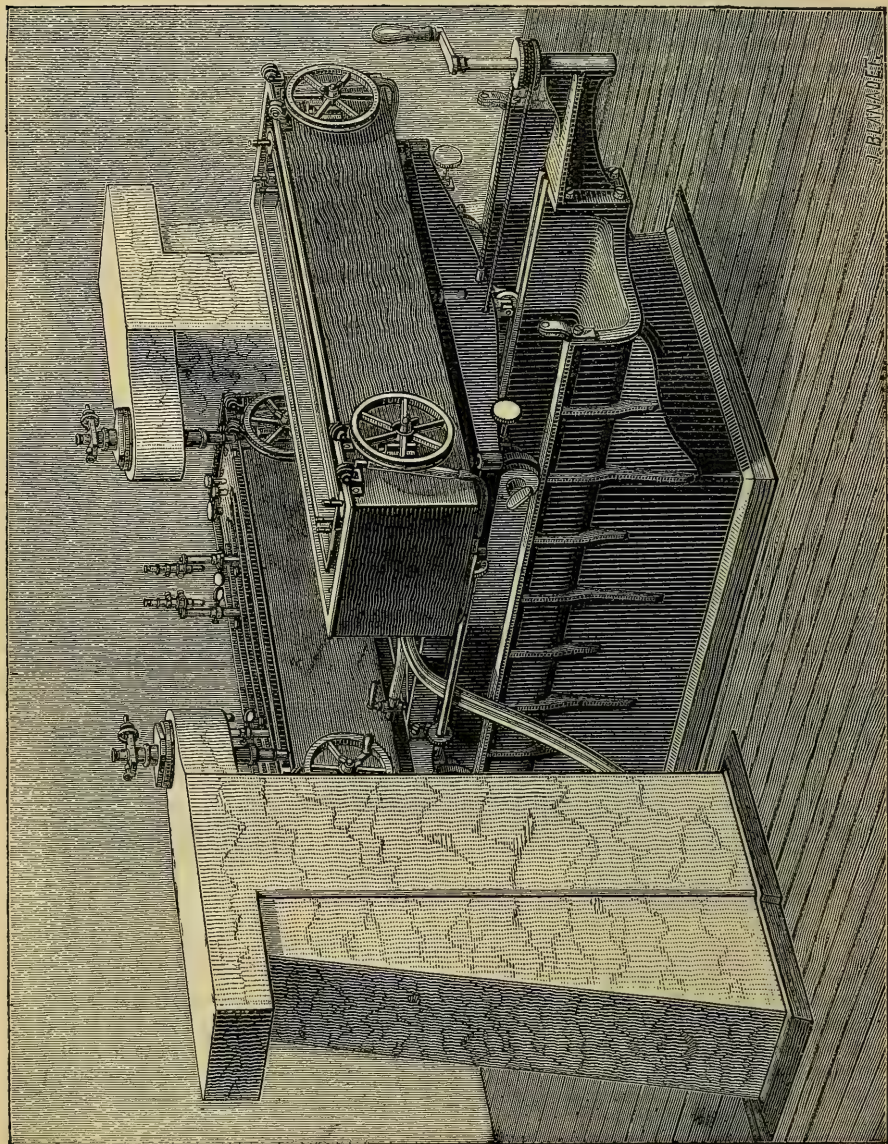


method of the "stops" is used in the comparison of either line or end measure standards of length. In this form of the comparator an effort was made to reduce the cost of construction without impairing the efficiency of the apparatus. The reduction effected in the cost was very considerable. The instrument shown in fig. 158 cost 2500 dollars, while that shown in fig. 159 cost only 800 dollars.*

* Cf. also a paper by Prof. W. C. Unwin, "Measuring-Instruments used in Mechanical Testing," Proc. Phys. Soc. Lond., viii. (1887) pp. 179-84 (3 figs.).

Geneva Co.'s Comparator.—The Geneva Society for the Construction of Physical Instruments constructed for the Bureau International des Poids et Mesures, at Paris, the comparator shown in fig. 160, for determining the co-efficients of dilatation of divided metre scales. In this four Microscopes are made use of.*

FIG. 160.



* Cf. description in the 'Mémoires du Bureau International des Poids et Mesures.' The two Microscopes on the stone pillars were made by MM. Brunner Frères, of Paris.

Geneva Co's. Reading Microscope.—In this Microscope (fig. 161) designed more particularly for astronomical purposes—the determination of the nadir with a mercury bath—the principle of the “Vertical Illuminator” is made use of for illumination.

Just below the 1 in. objective is a circular opening which admits light to a piece of thin cover-glass, which is supported on an axis which passes out at one side and terminates in a milled head. On setting the thin glass at the appropriate angle, light is reflected on the object under examination, while at the same time the glass does not obstruct the observer's vision through the eye-piece and objective. The upper milled head clamps the body-tube in the socket when it has been adjusted to the proper focus. The whole instrument is 4 in. high.

Cambridge Scientific Instrument Co's Reading Microscope.—This (fig. 162) is also intended for reading off measurements by the aid of a compound Microscope. The one figured has a single Microscope only, but some are supplied with two.

The Microscope slides in a socket attached to a frame which moves in a deep V-shaped groove on the top of a heavy open brass support. A micrometer screw acting against an upper and lower spiral spring moves the Microscope laterally, the extent of movement being indicated on a horizontal graduated bar, the periphery of a coned nut on the screw axis

FIG. 161.

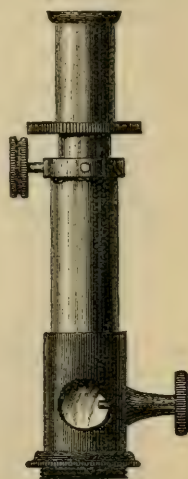
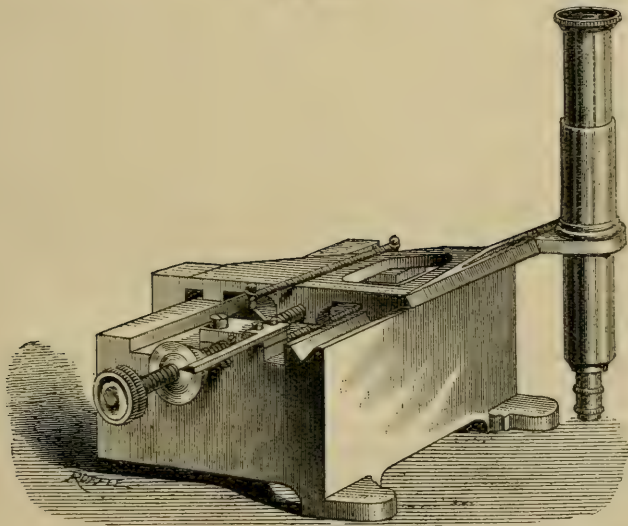


FIG. 162.

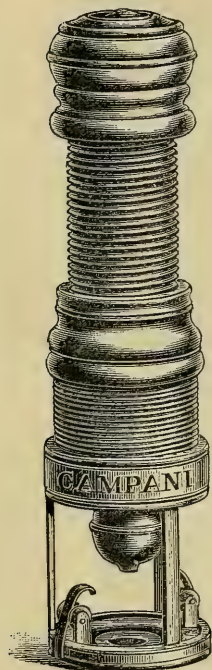


serving as the index. Fractions of divisions are recorded by graduations on the nut itself, the bar, which has a bevelled edge, here acting as the index.

Campani's Compound Microscope.—One of the earliest opticians known to have made a specialty of the construction of Microscopes was

Giuseppe Campani of Rome, who flourished in the latter half of the 17th century, when he was regarded as one of the most skilful makers of telescopes in Europe, outrivalling Eustachio Divini of Bologna, and in technical perfection of optical work not unworthy to rank with Huyghens. His Microscopes have now become so rare that we need hardly plead any other justification for figuring one of them (fig. 163) which we met with during a recent visit to Italy, and which is the first (to our knowledge) that has been figured.*

FIG. 163.



The body-tubes are of wood, and are provided with a double focusing arrangement, one (the lower) for regulating the distance between the object-lens and the object by screwing into the metal ring-socket supported on the tripod, the other for varying the distance of the eye-lens from the object-lens by a screw-motion of the upper tube within the lower one. The base consists of two plates, the upper one being attached to the tripod and the lower one being held to the former by the lateral pressure of a bent spring on either side travelling on rollers, the object-slide being placed between the plates, which are perforated in the centre so that the object may be viewed by transmitted light.

The object-lens is bi-convex, of somewhat yellow glass, and about $1\frac{1}{2}$ in. focus, and is held in a wood cell by a perforated cap, which serves as a diaphragm. The eye-lens is bi-convex, of about 1 in. focus. There is no field-lens, and hence we think the date of the construction may with some probability be assigned as prior to that of Hooke's compound Microscope (vide his 'Micrographia,' 1665), in which the application of a field lens was claimed as a novelty. In confirmation of this point we may note also that in 1667 Hon. Fabri, in his 'Synopsis optica' (4to,

Lugduni), Prop. 46, described a compound Microscope by Divini, in which two pairs of plano-convex lenses were used for the eye-lens and field-lens respectively, so that the application of a field-lens to the eye-piece of a Microscope was known in Italy at that date. Divini's Microscope was also fully described in the 'Giornale de Letterati,' i. (1668) pp. 52-4, which description was partly translated in Phil. Trans., iii. (1668) p. 842, and must have become widely known.

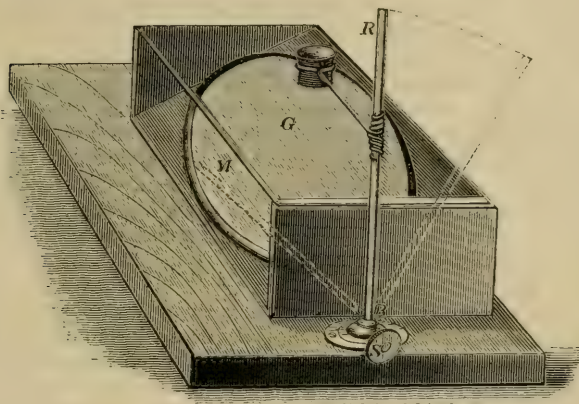
James's Dissecting Microscope.†—Dr. F. L. James uses a cigar-box from which the top and front side have been removed, an old hand-mirror, and a plate-glass cover (fig. 164). In use, this stands on a board which carries an upright rod, provided with a ball-and-socket joint. On this rod slides an arm made of wire, twisted so as to hold a watchmaker's eye-glass. When not in use the ball-and-socket joint permits this rod to be turned down out of the way. The object to be dissected or slide to be arranged is placed on the plate-glass cover. The light is thrown upward by the mirror and through the cover-plate, so as to render visible the minutest detail of

* Society of Arts Cantor Lectures on the Microscope, by J. Mayall, junr. (reprint in collected form) 1886, p. 10 (1 fig.).

† Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 145-6 (1 fig.).

the object to be arranged. In fact the entire combination is a sort of mounting and dissecting Microscope on a large scale.

FIG. 164.



BAUSCH, E.—Two new combined inverted and vertical Microscopes.

[Describes the Microscopes noted *ante*, p. 141.]

Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 148-9 (1 fig.).

Competition for the best Microscope.

["Notes from our London Correspondent." "Certain amateurs of the Microscope in London have been recently discussing the advisability of proposing a competition among opticians: (1) for the best stand for the highest class of work; (2) for the best stand to be supplied for a given sum, say 20*l.*; and (3) the best student's Microscope, costing, say, 5*l.* The suggestion is that a handsome gold medal might be awarded for the best instrument in each class. Special precautions would doubtless have to be taken in the two latter competitions to insure the strict fulfilment of the conditions as to the cost of the instruments. A jury would have to be named comprising microscopists of known skill in the use of the instrument, and one of the principal conditions would be that every Microscope would be put through its paces by one or other of the jury—not by the opticians or their nominees. If this matter could be brought to a focus I hope the American opticians will join in the competition. The intention is to arrange the fairest possible conditions, so that the awards may carry the highest possible authority."] [Nothing has been heard of this here!]

Queen's Micr. Bulletin, IV. (1887) p. 17.

CZAPSKI, S.—Die Mikrometerbewegung an den neueren Zeiss'schen Stativen. (The fine-adjustment to the new Zeiss stands.)

[Same as *Journal*, 1886, p. 1051, but different fig.]

Zeitschr. f. Instrumentenk., VII. (1887) pp. 221-2 (1 fig.).

NAGURA, O.—[The Choice of a Microscope.]

[Japanese.]

Tokio Med. Journ., 1886, No. 420.

NELSON, E. M.—New Microscope.

[Original description. Cf. this *Journal*, *ante*, p. 292.]

Journ. Quakett Micr. Club, III. (1887) pp. 85-8 (1 fig.).

STRICKER, S.—Demonstrationen mit dem elektrischen Mikroskop. (Demonstrations with the electric Microscope.)

Wiener Med. Bl., IX. (1886) No. 39.

(2) Eye-pieces and Objectives.

"New Glycerin Immersion Microscopic Objective."—We have been favoured by a firm of Manchester opticians with a copy of a notice under this heading in which the following statement is made:—

"Their experiments and experience prove glycerin to be a much better medium than water or oil. Water necessitates the Microscope being used

almost upright, and soon evaporates. Oil requires great care in manipulation and loss of time in cleaning off after use. *Glycerin is free from these objections.* It will remain three or four days limpid and free from evaporation, and only requires cleaning off with a camel-hair pencil dipped in water, and the lens dried with blotting-paper. This objective has more brilliant definition, deeper penetration, and a greater working distance from the object than any others of its class at much higher prices."

It is not a little surprising that in these days an optician should show such a want of appreciation of elementary optical principles. Glycerin having a lower refractive index than the oil used for immersion the objective is not a homogeneous-immersion objective, with which, therefore, it cannot be compared. Glycerin having a lower refractive index than the fluid used for homogeneous-immersion, the aperture of glycerin objectives, and with it the brilliancy of the definition, is necessarily reduced. The "deeper penetration" is of course simply a function of the reduced aperture. Why a glycerin objective should have a greater working distance it would puzzle an optician to say.

Apart from optical errors, it is equally erroneous to say that glycerin requires less care in manipulation and takes less time to clean off than oil, while its well-known tendency to absorb moisture, and therefore to change in index, is more than a compensation for its alleged freedom from evaporation. It will be news to many that "water necessitates the Microscope being used nearly upright."

Notwithstanding the glowing panegyric on this objective the notice of its virtues, although stating that it is a 1/16 in., omits any mention of its aperture.

Zeiss's Objective-changer, with slide and centering adjustment.—This contrivance (figs. 165 and 166) is designed to provide (1) accurate

FIG. 165.

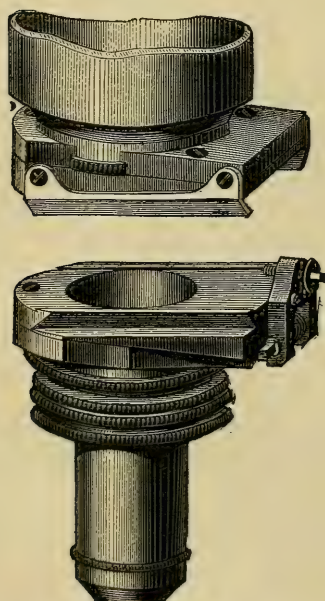
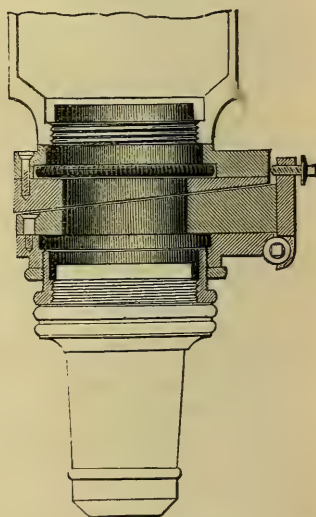


FIG. 166.



centering, and (2) rapid change of the objectives. It consists of two parts, the tube-slide and the objective-slide.

The tube-slide is screwed to the bottom of the body-tube. The plane of the sliding motion is purposely made, not at right angles to the axis of the instrument, but inclined at an angle to it, so that the objective falls and rises as it is inserted or withdrawn. In this way any danger of contact with the object is avoided. The objective is screwed to the objective-slide, and the plane of motion makes with the axis of the objective an angle which is the supplement of that of the tube-slide. At one end is a screw turned by a watch-key, which acts as a stop to bring the objective always back to the same position, and which also serves as a centering adjustment in the direction of the slide, while the adjustment in the transverse direction is effected by a similar screw working at right angles to the first.

Objectives whose settings are approximately compensated for their focal lengths can, by means of the clamp-screw on the objective-slide, be set once for all in their proper position. Any number of objective-slides may be used with one tube-slide. The two pieces fit one another accurately. The objectives always return to the same position, so that the same part of the object occupies the field of view.

HOPKINS, G. M.—*Diminishing the power of an Objective.*

["It is often desirable to diminish the magnifying power of an objective, and at the same time increase its penetration. For example, if one possesses a $1\frac{1}{2}$ in. or 2 in. objective, and desires to examine objects like minerals in the natural state, crystals, seeds, &c., he will find it necessary to focus up and down upon the object to see it in all parts. A 3 in. or 4 in. objective would furnish the desired power, but it is not at hand.

To increase the focal length, and at the same time enlarge the field and deepen the focus, it is only necessary to place a double convex lens of, say, 5 in. focus about half-way down the draw-tube. The action of such a lens is the reverse of that of an amplifier."]

Engl. Mech., XLV. (1887) pp. 310-1, from *Scientific American*.

(3) Illuminating and other Apparatus.

Value of Achromatic Condensers.*—Mr. E. M. Nelson and Mr. G. C. Karop write that an achromatic oil-immersion condenser has been made for them by Mr. T. Powell (Mr. Nelson having, in 1882, suggested to him the necessity for achromatizing the then chromatic oil-condenser) and that this has enabled them to illuminate objects by solid axial cones of larger angle than before; the spherical aberrations of a chromatic condenser being so great that only the rays passing through the centre or through a narrow zone of the condenser could be focused on the object at one time. The result has been a marked increase in resolution. In illustration of this increased resolution they refer to a drawing of an areolation of the same valve of *Isthmia nervosa*, which they figured in their former paper.† The straight bars of silex, by which the central delicate perforated membrane was shown to be attached to the margin of the areolation now have a trabecular appearance; the delicate membrane extends to the edge of the large areolation, and has perforations more difficult to resolve than those in the centre.

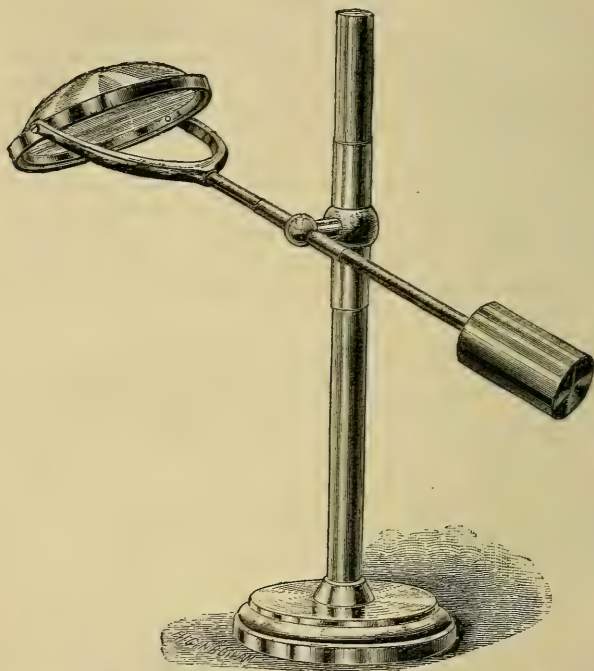
They point out that this is not a correction of misinterpretation of optical images, but a clear case of increased resolution, due to an improvement in optical appliances. Even now they do not wish to lay any claim to finality, but to show that every advance in perfecting instrumental appliances is attended by an increased gain in our knowledge of structure. In addition to the new condenser they have used Professor Abbe's new compensating eye-pieces, which give sharper images than those of the Huyghenian construction.

* *Journ. Quek. Micr. Club*, iii. (1887) pp. 41-3.

† *Ibid.*, ii. (1886) pp. 269-71 (1 pl.).

Bausch and Lomb Optical Co.'s Condenser.—The speciality of this condenser (fig. 167) is that one end of the cross arm has a weight acting as

FIG. 167.



a counterpoise to the bull's-eye lens at the other end. The lens is 3 in. in diameter.

Miles' "Desideratum" Condenser.*—Mr. J. L. W. Miles' condenser "consists of a plano-convex lens of given dimensions, having a ground spot in the centre; to this can be superadded an adjustable plano-convex lens of short focus. These can be used with or without a system of stops and discs with openings by means of a sliding spindle, which enables any size or character of stop to be placed close under, or at any distance from the lenses.

"The following is a recapitulation of the working capabilities of the condenser:—

"The back lens, used as a simple condenser for all powers, will be found to meet all the requirements of the ordinary microscopist. With a $1\frac{1}{2}$ in. objective of 70° or 80° aperture, and a C eye-piece, *P. angulatum* can be 'dotted' readily.

"Used as a combined condenser and light-modifier, it possesses advantages superior to the devices in common use.

"As a dark-ground illuminator, it leaves nothing to be desired, working easily with powers from 3 in. to $1\frac{1}{2}$ in. of 40° inclusive; and also with the 4 in. by increasing the size of the spot-stop.

"It gives binocular vision with $1\frac{1}{4}$ in. objectives, illuminating both

* Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 31-3.

fields of a binocular Microscope, in use with that power, remarkably well; hence, as may be inferred, there is no difficulty whatever in illuminating both fields with all lower powers.

"In combination with the front lens it has an aperture of 110° , and will, in conjunction with a suitable stop, give dark-ground illumination, with $1/4$ in. objectives, up to 100° of aperture, or with any power intermediate between that and the 1 in.

"The combined lenses, having a comparatively large aperture, will be found useful in all cases when a pencil of light of large angular dimensions is desirable, which is very seldom.

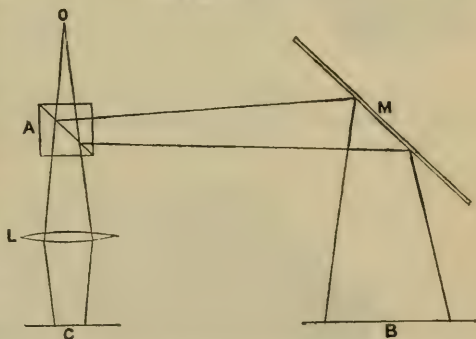
"Used with a stop having one or more side-openings, it will give unilateral or equidistant beams of light of considerable obliquity.

"Generally speaking, the stops, when used, are to be placed close under the lenses, but in practice it will be found that placing a large stop at some distance from the back lens will occasionally disclose structure when every other method fails. A unilateral beam of light, for resolving *P. angulatum* on a dark ground, is best got by placing a suitable stop on the back lens before screwing on the front.

"Last, and not least, of the merits of this condenser, is the low price at which it can be supplied, and adapted to nearly any Microscope. It has one fault; it is non-achromatic. This defect is not noticeable with low and medium powers. In using the combined lenses with high powers, the defect may be minimized considerably by careful focusing. Using one lens only, the defect will scarcely ever be noticed. As a matter of fact, only the most costly condensers are really achromatic. To make this into a so-called achromatic condenser would increase its cost, and render it useless for many purposes."

Nachet's Camera Lucida for Magnifiers.*—This apparatus, shown in fig. 168, consists of a glass cube A, formed of two prisms, one of which has an hypotenuse surface gilded on Prof. Govi's method. This is sufficiently transparent to transmit the rays from the object C to the eye at O at the same time as it reflects also to the eye the rays from the paper B and mirror M. The doublet or single lens is at L. The images are of two different tints, the one seen through the gold film being emerald green and that seen by reflection yellow. The difference of colour is said to be of advantage in making clearly visible the point of the pencil.

FIG. 168.



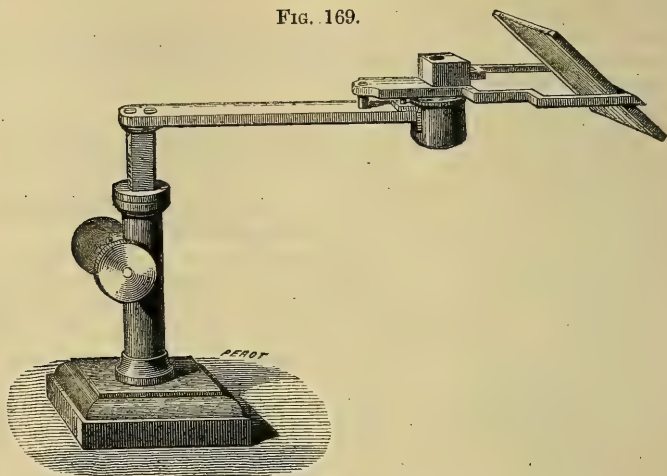
M. Nachet supplies the apparatus in connection with the stand, fig. 169.

The instrument can also be used to reduce drawings, which are placed under the mirror M and the paper under the lens L; for this purpose the mirror is made to rotate and an extra low power lens is used. As the smallest movements of the pencil are followed by the lens, these reductions

* Robin's (C.) 'Traité du Microscope,' 2nd ed., 1877, pp. 429-31 (2 figs.).
1887. 2 U

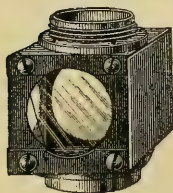
have, says Prof. Robin, "a character of precision and finish quite remarkable."

FIG. 169.



Prism for Drawing.—In accordance with our custom of chronieling microscopic apparatus actually brought to the condition of practical manufacture and use, we note this device of an anonymous designer.

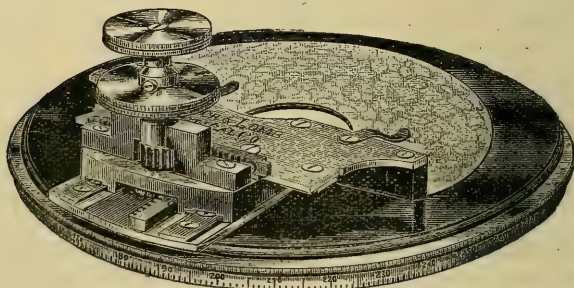
FIG. 170.



It consists of a right-angled prism, not attached above the eye-piece, but placed at the nose-piece over the objective, the image being reflected on paper placed on the table on which the Microscope stands. It cannot, however, be used with ordinary Microscopes where the body-tube is in front of the limb, but only with such forms as the Watson-Moss,* where the body-tube is at the side.

Bausch and Lomb Optical Co's. Mechanical Stages.—These are made in the two forms shown in figs. 171 and 172. Fig. 171 is $4\frac{1}{2}$ in. in diameter,

FIG. 171.



and is intended to be used with the "Concentric" and "Professional" Microscopes. It is thin, to allow great obliquity, but firm. The movements are contained within the circumference of the stage, so that it can make

* See this Journal, 1881, p. 516.

a complete rotation. The rectangular movements are delicate and actuated by two milled heads, placed one above the other (Turrell form). The upper part of the stage is polished black glass; the edge is milled, graduated to degrees and silvered.

FIG. 172.

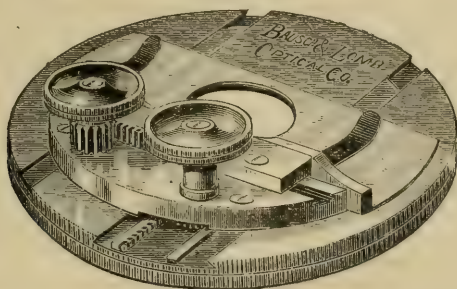
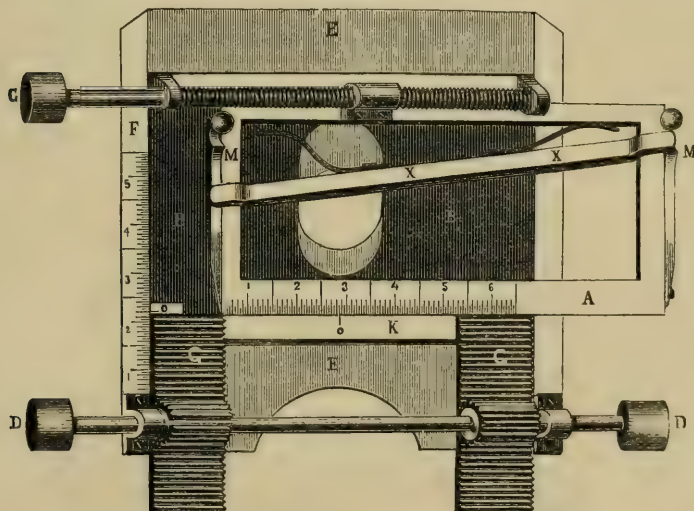


Fig. 172 can be adapted to any Microscope which will admit of a stage $3\frac{1}{2}$ in. in diameter. The movements are all contained on the upper surface of the stage, and it can therefore be completely rotated. It is thin and will admit the use of very oblique light.

Smirnow's Microstat.*—Dr. A. Smirnow describes, under the name of microstat, an apparatus which he has constructed to obviate the great

FIG. 173.



inconvenience of examining the whole of a large object under high powers, or of re-finding minute objects, such as Bacteria, in a large preparation. The purpose of the instrument is much the same, he notes, as that of Klönne and Müller's Bacterium finder.

The principle of the contrivance is based on the fact that any point

* Russ. Med., 1886, No 27 (in Russian). Arch. f. Mikr. Anat., xxix. (1887) pp. 384-8 (1 fig.).

may be determined by its distance from two fixed points or lines on the same plane. The slide is placed in a frame A and kept always in the same position by a rod X. Before the slide is inserted the rod X is pressed forward to the anterior margin of the frame where it is held by two teeth M. By pressing the knobs of the teeth, the rod is released and springs back so as to fix the slide in a given position. The frame is moved from right to left by a micrometer screw C. On an immovable plate K, a permanent point *o* is marked, and the adjacent margin of the movable frame is divided in 0.25 mm. Thus one line on the preparation is defined. But the frame A is fixed to another movable plate B B which is worked by the rack and pinion G, D, on an inferior fixed plate E E, and in an antero-posterior direction. One margin F of this fixed plate is also graduated, and there is another fixed point *o*, so that the desired point in the field can be defined in two directions, and therefore readily determined. The plates B B and E E have apertures for illumination. The attachment to the stage is a simple matter.

The whole field can be systematically observed, a point can be registered and readily found again, the size of large objects can be measured, movements of organisms can be defined, and the comparison of lent preparations greatly facilitated.

Notwithstanding the fulness of the description and the renown of the German periodical in which it appears, it must be said that the "Microstat" is simply a mechanical stage with finders, and in this country at any rate has no feature of novelty.

Darling's Screw-Micrometer.*—Mr. S. Darling has devised two forms of screw micrometer, in which he claims there is "no perceptible play between the threads of the screw and the nut," and in which "the screw will revolve much farther, relative to the motion of the cross-hairs, than in the micrometers heretofore made;" and further, that he has found "a substitute for the common cross-hairs (spider's web), by which measurements can be made with greater accuracy and uniformity."

One form of his micrometer (fig. 174, top view, with top E removed; fig. 175, section of fig. 174 through A B) has a V-thread screw and nut, the nut

FIG. 174.

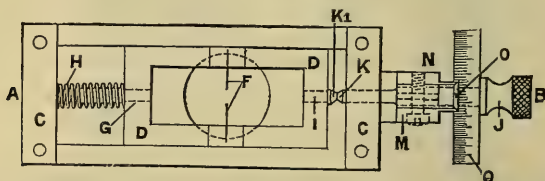
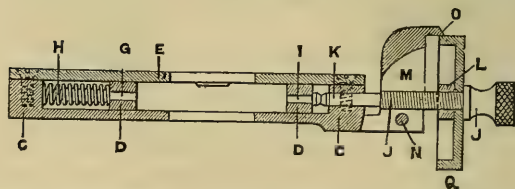


FIG. 175.



being split at one end and a screw tightening the nut. The frame that carries the cross-hairs has a very small hard abutting-piece coming against

* Specification of U.S. Patent, No. 287,420, Oct. 30, 1883.

the end of the screw; the screw also being made hard and preferably small. In another form (fig. 176 top view, with the top E removed; fig. 177, section of fig. 176 through R S), two screws are made on the same piece, each made

FIG. 176.

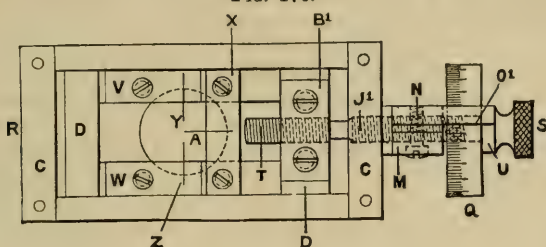
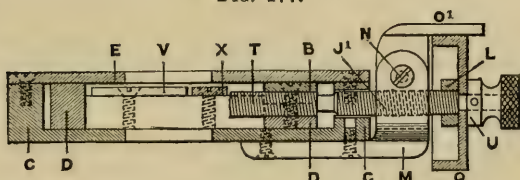


FIG. 177.



of a different pitch, and a whole or split nut for each part of the screw, one nut and the corresponding screw being attached to the frame that carries the cross-hairs.

He proposes to use wires of glass or other suitable material instead of spider-webs, and to apply short cross-wires parallel with and opposite to each other, leaving a space between them and in various positions, so that the operator can have several points to guide him in adjusting the micrometer on the object to be measured. He says,—

“It is well known to mechanics that a screw loose in the nut cannot be depended upon for great accuracy and uniformity in measurements, notwithstanding the slack may be taken up by a spring, as particles of matter are liable to get between the threads and cause errors. That difficulty is avoided in this improved micrometer. From experiments it is believed that the cross-hairs in a micrometer made according to this improvement can be adjusted to a line a number of times—say five, more or less—within an error of 0·00005 of an inch. It greatly facilitates the adjusting of the cross-hairs to a line to have the screw move a considerable part of a revolution for each division of the index-wheel. It is difficult to move the screw made in the ordinary way little enough to adjust the cross-hairs in the most accurate manner, and the difficulty in moving it little enough often influences the operator to accept an adjustment as correct with which he is not fully satisfied.

In the drawings I have illustrated a screw made in two parts on the same piece, one part being 20 pitch and the other 25 pitch, which gives a movement to the cross-hair frame of $1/100$ in. each revolution, this being intended for ordinary work; but in a micrometer for very fine measurements I should use a screw from 35 to 40 pitch. 36 and $37\cdot037$ pitches would be $3/4000$ in. approximately, to each turn of the screw, and the object being magnified fifteen times, and the index-wheel divided into ten parts, one division on the wheel would be $1/200,000$ in., and the

index-wheel being about 1.2 in. in diameter, it will be seen that the lines on the screw or index-wheel will be over 0.35 apart, instead of one-tenth (0.035) of that, when the wheel is divided into one hundred parts, in the usual way."

"I have illustrated two methods of making micrometers, which vary from each other in some respects. One method is shown in figs. 174 and 175, and the other in figs. 176 and 177.

In figs. 174 and 175, C is a case with top removed, inclosing the cross-hair frame D. F are wires attached to sliding frame D. These wires may be made of metal or any suitable material, and should be from 1/500 in. to 1/1000 in. in diameter. Glass is a good material to make the wire of, as it can be pulled apart and a square end obtained. The wires can be secured to the frame by wax or any other suitable means. There may be one wire only, or two, as shown in fig. 174, or any number desired, and they may be placed in any position, as shown at A, Z, and Y, fig. 176, or any other preferred. M is a split nut. N is a screw for bringing the two parts of the nut together. J is a screw which passes through nut N, and terminates in a small hardened abutting-end K. O is an index-line. I is a small hardened abutting-piece attached to cross-hair frame D. G is a rod for holding spring H in position. Q is a graduated index-wheel. E is the top to the case C.

V W X, fig. 176, are adjustable pieces, to which the wires are attached; T the part of the screw which is 20 pitch; J₁ the part that is 25 pitch. The screw J₁ passes loosely through the frame C.

It will be seen that by means of the split nut and screws N all play between the nut and the screw can be prevented. Nut B' may be split at one end, the same as nut M, or made in two parts, with two screws as shown.

It is evident that with the nuts properly adjusted the frame that carries the wires (cross-hairs), fig. 176, must move with the screw without variation. The arrangement shown in figs. 174 and 175 has the advantage of the split nut, and in addition to that very small abutting-surfaces, so that there will be much less liability for dust or oil to get between the abutting-surfaces K and I than in the usual form.

There is a great advantage in having several points to aid in adjusting the cross-hairs to a line. If the operator is in doubt whether one point coincides with the line, the other points will help him to decide directly.

In fig. 174 the nut M may be made in the frame D, as shown at B', fig. 176, instead of being located outside of case C; but in that case the advantage of the small abutting-surfaces I and K would be lost; but it would be better than the usual form.

The index-wheel is divided into ten parts and each part into five fractional parts. Now, with the two pitch-screws 36 and 37.037 pitches, as above described, one division of the wheel will read 1/200,000 in., and each fractional part will read 1/1,000,000 in., for with a Microscope that magnifies fifteen times, one turn of the screw being 3/4000 and one division of the wheel being 3/40,000, and this magnified by fifteen times gives $3/600,000 = 1/200,000$, and one-fifth (the fractional parts), will give the 1/1,000,000.

The advantage in using the end of a wire instead of the side of a spider-web in the usual way, is that the full size of the line is always in view, and, having the wire nearly the size of the line, it is much easier to judge when the two coincide than when the line is covered by the cross-hairs, as in the common way, and when more wires than one are used each one will serve to correct a mistake that might be made with one alone."

Pagan's Growing Slide.*—The Rev. A. Pagan's slide was designed mainly for the purpose of watching the development of rotifers and other organisms which require a constant change of water. Figs. 178–81 give the essential points of its construction, which is very simple, and so far effective as to have enabled Mr. Pagan to observe the growth of the spores of *Volvox globator* after they had been confined to the slide for six weeks, the actual process of germination taking three days to complete.

Fig. 178 is a longitudinal vertical section of the whole apparatus drawn to a scale of half the actual size. A is a wooden stand supporting a glass

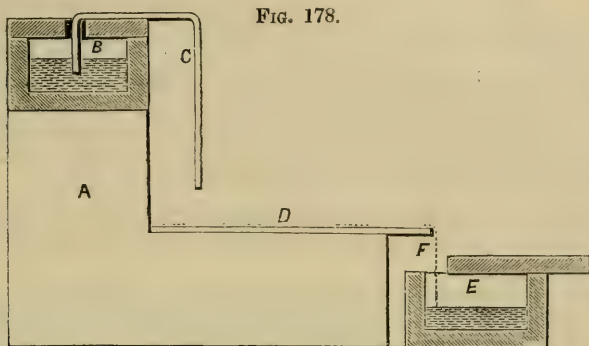
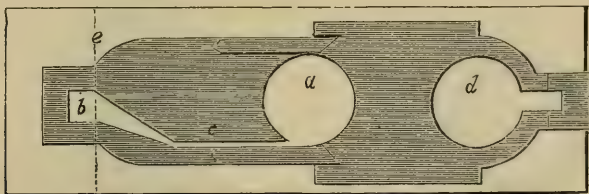


FIG. 178.

trough B, from which a water supply is conveyed to a slide D by a siphon C. This siphon is made from an ordinary capillary vaccine-tube, bent over a minute gas-flame. The water is conveyed from the slide by means of a spout F, made of blotting-paper, to another trough or suitable receptacle E.

Fig. 179 shows in full size an arrangement cut out of blotting-paper, and placed on an ordinary slide, *a* being a circular hole for containing the object under observation. This hole is connected by a narrow channel *c* with another hole *b*, shaped as in the drawing, and so placed beneath the siphon *c* as to receive a drop of water as it falls. It is sufficient, however, if the drop

FIG. 179.



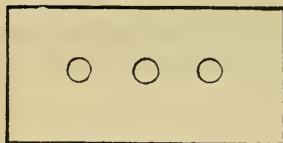
falls on the blotting-paper. A third hole *d* serves to collect the superfluous water, and also acts as a reservoir when the slide is under examination with the Microscope, water being applied there from time to time with a camel's-hair brush.

When it is desired to use the instrument, the blotting-paper is wetted and put on the slide, the drop of water containing the organism placed in the hole *a*, and the whole is covered with thin glass up to the dotted line *e*,

* Journ. Quek. Micr. Club, iii. (1887) pp. 81–3 (4 figs.).

three $3/4$ in. square cover-glasses being very suitable for this purpose. The siphon may now be started, the current being regulated to about one drop per minute by means of a linen thread, unravelled, soaked in water to get rid of air-bubbles, and pushed up the shorter limb of the siphon. The

FIG. 180.



water is drawn off at the other end of the slide by three strips of blotting-paper, one broad and the other two less than half the width, placed under the broad slip, thus forming a kind of channel for the water to flow through.

After a time the blotting-paper is liable to get clogged, and will not allow the water to filter through; it must therefore be changed. To enable this to be done the part used on the slide is cut in pieces in the manner indicated in fig. 179.

The form of the lid of the trough B is shown in fig. 180. It is provided with three holes drilled 1 in. apart, in order that, when desired, three separate slides can be kept under treatment at the same time.

Apparatus for examining living Myriopoda.*—M. J. Chalande employed the following simple apparatus for microscopical observation of living Myriopoda:—

Two glass slides are fixed, one over the other, by sealing-wax along the two sides, leaving a space of 1–2 mm. between the two slides to allow the myriopod to be introduced. One end of the apparatus is closed by means of a small piece of cardboard. The space between the two slides must vary according to the size of the specimens to be examined, and for very small forms the author substituted a cover-glass (32 by 12 mm. and $1/5$ mm. in thickness) for the upper glass slide.

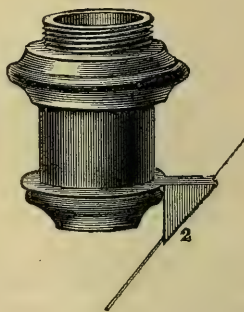
In order to give the myriopod foothold, he gummed some particles of sand to the lower slide at various distances apart. If this is not done, the animal continues to struggle, as it endeavours to find something to hold on to.

Griffith's Mechanical Finger.†—Mr. E. H. Griffith says that a cheap mechanical finger, for those who cannot afford to purchase a better one, may

FIG. 181.



FIG. 182.



be quickly made as follows:—Procure a strip of sheet brass or other metal, and cut it like fig. 181. Make the aperture just large enough to fit over the

* Bull. Soc. d'Hist. Nat. Toulouse, 1886. See this Journal, *ante*, p. 385.

† Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, p. 150 (3 figs.).

screw which fastens the lower system of a low-power objective to the barrel of the objective. Bend the points (1 and 2) down, so that they will meet and serve as a bristle clamp. Remove the lower system of the objective, and put in the thin brass plate as in fig. 182; then draw a cat's whisker between 1 and 2, and the finger will be ready for use as soon as the point of the whisker is in focus and in the centre of the field.

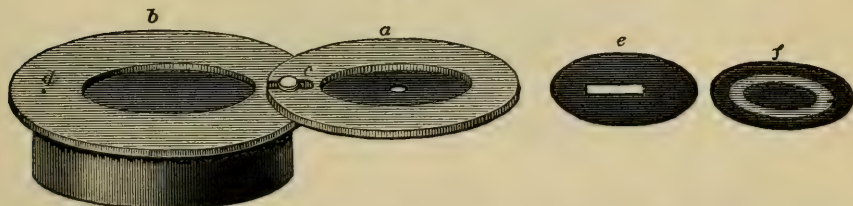
FIG. 183.



A divided wire might be soldered on the ring in fig. 182, and it would answer the same purpose (see fig. 183).

Griffith's Substage Diaphragm-holder and Glass Diaphragms.*—Mr. E. H. Griffith's holder is a metal disc *a* (fig. 184), which is to be fastened to the substage fittings *b*, by means of the screw *c*, which allows it to be turned in any position. An aperture of any desired diameter is made in the holder *a*, and provided with a ledge for the support of diaphragms

FIG. 184.



which may be dropped into position when the holder is turned on one side, as would be indicated in the fig. were the disc turned over. The slot at *c* allows the diaphragm to be placed central with the objective on a decentered stage. The screw-head at *c* should be of sufficient size to retain the holder in any position it is placed. The pin *d* is to indicate a central position when the holder is to be used on a well-centered stage.

Thin metal discs with various apertures may be used for diaphragms, but much cheaper ones may be made by placing common round cover-glasses *ef* on the turntable, and with a brush quickly covering all but the desired aperture with asphalt or other pigment. In the place of diaphragms, various coloured glasses for the modification of light may be used.

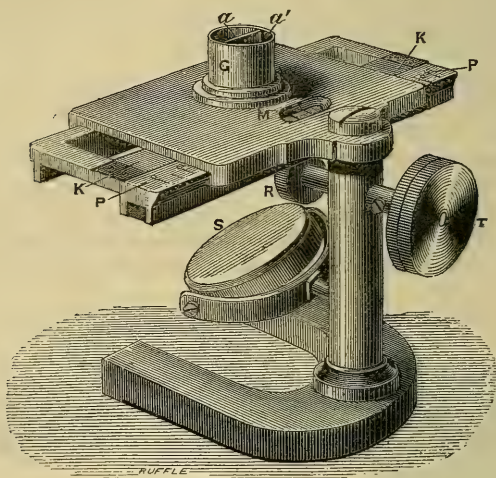
Fleischl's Hæmometer.†—This instrument, fig. 185, devised by Prof. E. v. Fleischl for the estimation of hæmoglobin in the blood, is based on the colorimetric method; that is, it compares the colour of red glass with that of a solution of the blood, and from the thickness of the stratum of the solution or of the glass when the tints are the same the amount of colouring matter present in the blood is determined. Prof. Fleischl finds, however, that although it is easy to prepare a plate of red glass which has exactly the same colour as a certain thickness of a solution of blood, yet if the thickness of the plate be increased *n*-fold it no longer has the same depth of colour as a solution of the same blood concentrated *n*-fold,

* Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 150-1 (1 fig.).

† Med. Jahrb. K.K. Gesell. Aerzte Wien, 1885, 20 pp, and 1 pl.

or as the same solution increased n times in thickness. This peculiarity, which may totally vitiate the colorimetric method if proper precautions are not observed, is due to the fact that though the absorption of light by the glass and the blood-solution respectively are directly comparable so far as red light is concerned, there is no such direct relation for the violet

FIG. 185.



rays; hence it is absolutely necessary to eliminate the violet rays from the source of illumination, and when this is done the relation is complete for all thicknesses of the plate and the solution. For this purpose the comparison must be made not by daylight nor with electric or petroleum light, but either by candle-light or with an oil or gas flame; if this cannot be done, a plate of light-yellow glass must be interposed between the instrument and the source of light. Another feature of Prof. Fleischl's method is that the constant quantities are not, as is usual, the concentration of the solution and its thickness, but the absolute volume of the blood examined and the sectional area of the cylindrical vessel in which the solution is contained, the thickness being immaterial.

The hæmometer consists of a glass tube G, $1\frac{1}{2}$ cm. in length and 15–20 mm. in diameter, closed at the bottom by a glass plate, and divided into two semi-cylinders a a' of equal size by a vertical glass plate 0.5 mm. thick. The cylinder is fixed to the stage over a circular aperture, through which light is projected from the mirror S, formed of a plate of fine white gypsum. Beneath one half of the aperture is a wedge of red glass K, movable by the pinion and milled head R T, so that any part of the wedge may be brought under the aperture.

The instrument is used in the following way: the two halves of the glass tube are filled to any height with water; in one is dissolved a unit volume of the blood, and the coloured glass is then shifted until the two semi-cylinders show the same colour. The position of the wedge is then read upon the graduated scale P through the opening M in the stage, the graduations being arranged so as to give direct the percentage of colouring matter as compared with the normal proportion of hæmoglobin contained in healthy blood.

To transfer a fixed quantity of blood to the glass cylinder Prof. Fleischl uses what he calls an "automatic blood-pipette," made by dividing a fine thermometer tube into lengths of equal capacity by sliding a short column of quicksilver from one part to another of the tube and marking the glass at the ends of the column (which is not less than 1 cm. in length) with a diamond. The tube is then cut through at these points, and each length is ground to a conical termination at each end and provided with a short holder of silver wire. If the end of one of these pipettes is immersed in a drop of blood it becomes filled by capillary attraction, and a unit volume of the liquid may thus be transferred to the glass cylinder.

Measurement by Total Reflection of the Refractive Indices of Microscopic Minerals.*—M. J. Thoulet describes a contrivance for measuring the indices of minerals under the Microscope by Kohlrausch's method of total reflection. The only microscopic methods which have been employed with advantage are those of the Duc de Chaulnes and of Mallard, but in both of these it is necessary to have a section of the mineral and to determine the thickness of the section with accuracy; with Kohlrausch's refractometer it is only necessary to have a plane surface of the mineral immersed in a liquid of greater refractive index, so that a natural crystal face may conveniently be employed. In this apparatus, as is well known, the liquid of high refractive index is contained in a cylindrical vessel surrounded by oiled paper, which serves to illuminate the interior with diffused light except at the point occupied by the observing telescope, and the mineral is supported on a rotating axis, which coincides with the axis of the cylinder. When the normal to the crystal surface makes with the axis of the telescope an angle equal to that of total reflection, one-half of the field of view is illuminated by totally reflected rays. The field is consequently divided into two equal parts of very unequal intensity. If the angle between the two positions at which this occurs is $2i$, then i is the angle of total reflection, and the index of the mineral is $\mu \sin i$, where μ is the known index of the liquid.

M. Thoulet's contrivance is merely the total refractometer of Kohlrausch applied in a simple form to the stage of Bertrand's Microscope.† A plate of blackened brass fixed to the stage by the screws $d d$ carries the graduated semicircle s (of which R is the axis) moved independently by the milled head A , and carrying the vernier t with it when moved by B . This axis carries not only the object o , but also the small cylindrical tube M , into the cork a of which it fits closely. This tube contains the bisulphide of carbon or other liquid which surrounds the object, and being completely closed prevents evaporation. M is surrounded by a second cylindrical tube N , open above, but closed below by the cork P . This tube is fixed to the holder D by a point which enters P ; and D , being attached to the stand of the Microscope by the spring clip C , may be adjusted by hand to any desired position. The tube N is covered with oiled paper except along a narrow band parallel to its axis, which is brought opposite to the objective E by turning the milled head G .

The tube M having been filled with carbon disulphide, and the object fixed at O with its face parallel to the axis (gum arabic may be used for this purpose, being insoluble in the liquid), the whole apparatus is rapidly centered and adjusted by the stage movements and those at G and C ; the angle of total reflection is then determined in monochromatic light by the goniometer, which is divided to tenths of a degree, and which by

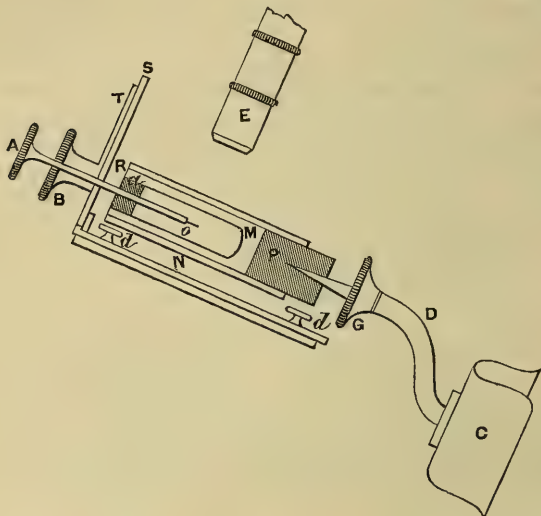
* Bull. Soc. Minéral. France, 1883, pp. 184-91 (1 fig.).

† See this Journal, 1883, p. 413.

repeated measurements gives the angle to about 2 minutes, corresponding to units in the third place of decimals.

In using the instrument the objective is replaced by Bertrand's lens for convergent light, or the objectives 0 or 1 of Nachet may be employed.

FIG. 186.



As regards the liquid, there are many objections to the use of carbon disulphide, and M. Thoulet recommends biniodide of mercury and potassium as more convenient than either naphthaline monobromide or solution of sulphur or phosphorus in carbon disulphide. In any case it will not be possible to determine an index of refraction which is greater than 1.7.

A Microscopic Advantage.

["By inverting a 1/4 in. objective over the eye-piece of the Microscope an arrangement is produced which immediately gives the images in their proper position, and not upside down, as without it. This is a considerable advantage, because it enables a worker to go straight to the object without the mistakes which so frequently occur with beginners."]

Scientif. Enquirer, II. (1887) pp. 106-7.

HÄLLSTÉN, K.—Ein Compressorium für microscopische Zwecke. (A compressorium for microscopical purposes.)

[A brass tube surrounding the objective, at the lower end of which a cover-glass is cemented with shellac. It can be used as a compressorium, and also to prevent the dimming of high powers with water vapour when observing delicate transparent objects in the living condition on the hot stage.]

Zeitschr. f. Biol., XXII. (1886) pp. 404-7 (1 fig.).

Ketchum's (J.) Portable Oxy-calcium Lamp.

["When packed occupied a case only 13 in. long by 6 in. square. The oxygen cylinder was 3 x 12 in. long, and contained four hours' supply. The illumination was very fine."]

Amer. Mon. Micr. Journ., VIII. (1887) p. 97.

Laboratory Notes.

[Usefulness of a simple and inexpensive eye-piece micrometer as a part of the outfit of each Microscope in the laboratory. Culture-cells made of vulcanite rings.]

Amer. Natural., XXI. (1887) pp. 477-9.

N., W. J.—The Two Mirrors. No. VI.

Sci.-Gossip, 1887, pp. 75-6 (1 fig.).

Polariscope, single, for the Toy Microscope.

[Made of sixteen or eighteen cover-glasses.]

Engl. Mech., XLV. (1887) pp. 337-8 (2 figs.), from *Scientific American*.

ROGERS, W. A.—"Microscopic metal thermometer, by which the indicated temperature is read off upon the eye-piece micrometer of the Microscope."

Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, p. 190.

Schroeder's New Lieberkühns.

[Made of Wolfram steel.]

Journ. Quekett Micr. Club, III. (1887) p. 92.

SELENKA, E.—"Die elektrische Projections-lampe. (The electric projection lamp.)"

SB. Phys.-med. Soc. Erlangen, 1887, 8 pp.

TATHAM, J.—"Illumination of Objects under the Microscope."

Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 78-9.

THANHOFFER, L. v.—"Mikroskopische Gaskammer. (Microscopical gas chamber.)"

[Contains only the following abstract—"with which the author investigated under rarefied and compressed air or in different gases the movements of the protoplasm or the circulation of the blood in small transparent animals."]

Math. u. Naturwiss. Ber. Ungarn., IV. (1886) p. 218.

VANDERPOEL, F.—"Improved settling tube for urinary deposits."

Amer. Mon. Micr. Journ., VIII. (1887) pp. 71-2 (4 figs.) pp. 115-6.

WARD, R. H.—"Micrometer Wires."

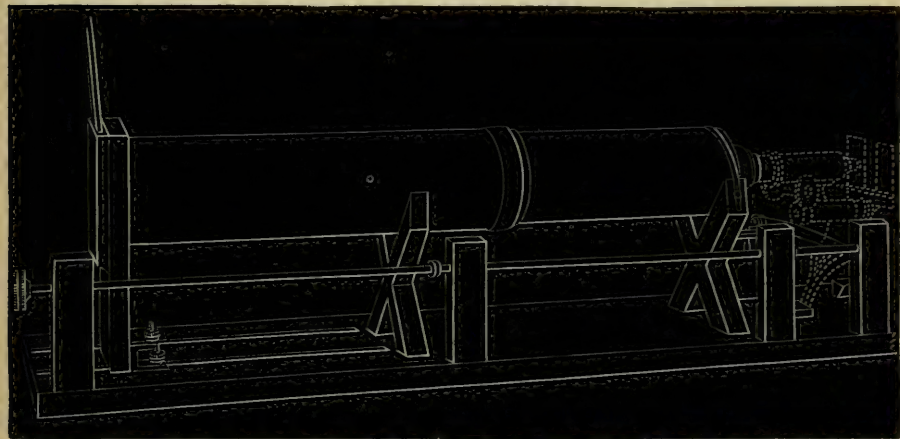
[Recommends the use of platinum wires in preference to spider threads.]

Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 89-93.

(4) Photomicrography.

Nelson's Photomicrographic Camera.—This camera (fig. 187) was designed by Mr. E. M. Nelson in conjunction with Mr. C. L. Curties, especially for use with Prof. Abbe's new 3-power projection eye-piece. The apparatus consists first of a base-board, which is of sufficient length to take the camera when fully extended, the Microscope, and the lamp. The axis of the camera is fixed at the same height above the board as the optic

FIG. 187.



axis of the Nelson Model Microscope, but can be arranged to the height of any stand.

The camera itself consists of two cardboard tubes, which are light but strong, the one sliding into the other like the tube of a telescope; the joint between the two tubes is made light-tight by a velvet flap which is fastened down by an indiarubber band. The joint between the Microscope and camera has the usual light-excluding tubes. The camera when closed and used with the 3-power projection eye-piece is arranged to give a magni-

fication of about five times the initial magnifying power of the objective employed, and when fully extended gives ten times the initial power of the lens. The outer cardboard tube is fastened to an upright piece of wood which is clamped to the baseboard by thumb-screws at any point of its extension. The focusing screens of grey glass and plain glass with ruled lines, slide in grooves at the back of the upright piece of wood. The double back is the well-known Tylar patent metal one, which is cheap and efficient. This back is not a fourth of the cost of the wooden ones, and is free from the objectionable sticking of the slide due to the warping of the wood. The focusing is effected by a rod which runs down the right-hand side of the camera, a string passes round this and over a pulley on the other side of the board, taking a turn round the milled head of the fine-adjustment screw. This string is kept tight by a piece of elastic. The feet of the Microscope fit into blocks fastened on the baseboard.

Mr. Nelson especially recommends the aplanatic lens No. 127 in Zeiss's catalogue, power 6, as a focusing glass, and says that "the whole of the apparatus, viz. camera, Microscope, and lamp, is produced at a cost less than is usually paid for a camera alone. It is not a makeshift which is only capable of doing fairly good work, but it is proved by practical experience to be equal to the highest class of work. The Campbell differential screw fine-adjustment will be found peculiarly serviceable for photomicrographic work, as it is slow and free from spring, which is the bane of every geared-down fine-adjustment." *

Photomicrographic Camera for the Simple or Compound Microscope.†

—Dr. P. Francotte's camera is intended specially for Mayer's simple Microscope, but can be used with any instrument in a vertical position. Low powers only are used. In form the camera is merely a pyramidal box with four sides. The topmost side carries a quarter-plate frame (9×12). The lower one is fitted with a brass tube by which it is arranged in the Microscope. By means of three screws, exact centering is perfectly obtained. A frame with ground glass serves for the superficial point and the regulation of light, and for the exact point a frame with transparent glass and a single lens of low power is used. The frame for the sensitized plates is double, and is supplied with two intermediate arcs, the one for a glass $6 \times 4\frac{1}{2}$ (quarter plate cut in two), the other for a quarter plate cut in four. With Steinheil's lens and monochromatic light, beautiful clichés of entire sections of larvæ of Salamander, &c., 15–18 mm. in length, were obtained. The images were 9–11 cm. long. The sections were stained with picrocarmine and the plates used were those obtained from Attout-Taillefer or those of Monckoven or Beernart sensitized for red rays by quinoline blue (cyanine).

The apparatus also gives good results with the compound Microscope, with or without the ocular.

Focusing in Photomicrography.—The inconvenience of focusing by means of long rods has been attempted to be obviated in several ways. One method, by the substitution of a piece of white paper for the ground glass, viewing the image from an opening at the side, was described in this Journal, 1886, p. 841.

To accomplish the same object, Dr. B. Benecke ‡ inserted a telescope with a right-angled prism in the front part of his camera (fig. 188), by means of which the image on the screen of white paper at the other end of

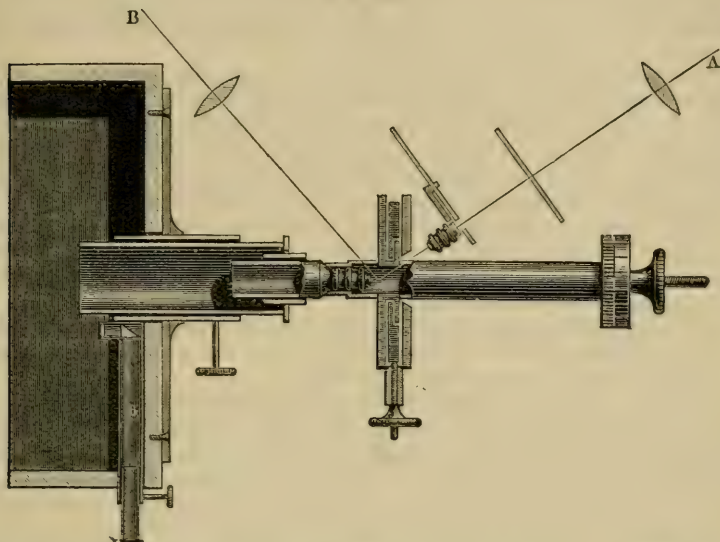
* Cf. Engl. Mech., xlv. (1887) p. 213.

† Bull. Soc. Belg. Mier., xiii. (1887) pp. 149–51.

‡ 'Die Photographie als Hilfsmittel Mikroskopischer Forschung,' 1868, pp. 74–5 (1 fig.).

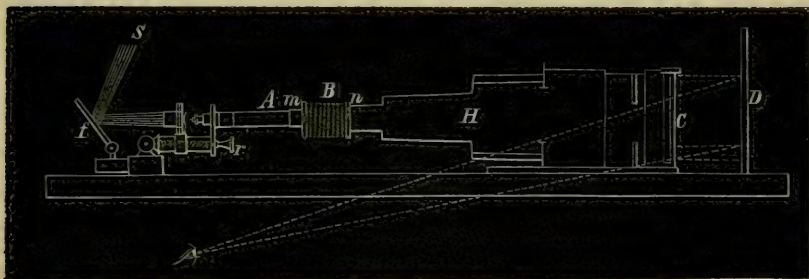
the camera was focused, the observer's head being thus in close proximity to the Microscope. (A and B are intended to show the mode of illuminating an object by oblique transmitted, and by reflected light.)

FIG. 188.



Dr. S. T. Stein* adopts the following method of focusing. The Microscope A (fig. 189) is first adjusted by direct vision until a clear image of the object is obtained; the eye-piece *m* is then removed and the body-tube united with the wooden chamber H by means of the black cloth connection B, which has rubber collars at *m* and *n*, and admits no light; the rays from the mirror *f* throw a blurred image of the object upon the ground-

FIG. 189.



glass plate of the camera C. Behind the camera is the plane mirror D, in which the observer whose eye is near the Microscope sees this image; he is thus in a position to adjust the Microscope until a well-defined image is thrown upon C by the direct use of the micrometer-screw *r* without the

* Stein, S. T., 'Das Licht,' 8vo, Halle, 1884, pp 231-2 (1 fig.). Cf. also J. Girard's 'La Chambre noire et la Microscope,' 2nd ed., 1870, pp. 52-3 (1 fig.).

intervention of any complicated mechanism such as is necessary from the usual position behind the camera. It may be convenient to examine the image with a small telescope or opera-glass.

Photomicrography with High Powers.*—Dr. O. Israel draws attention to the photomicrography of fresh objects, especially of vegetable micro-organisms in their natural condition, by the application of high powers and the use of good bromide gelatin plates.

For most microbes it is necessary to use very narrow diaphragms in order to reproduce the fineness of their lines with sufficient clearness; and as thereby much light is lost, long exposure becomes necessary. Hence also a very stable apparatus is a *sine quâ non*. The duration of the exposure is dependent on the clearness of the microscopic picture, and this in its turn depends on the source of light, the objective, and the size of diaphragm.

Diffuse daylight gives the best light, and for high powers and immersions a condenser is either desirable or necessary. Dry, water, and oil-immersion lenses are all applicable, though the best results were obtained with Hartnack's immersion ii. with correction.

It is of great importance that the object to be photographed should be very thin, in order that the parts above or below the plane in focus should not detract from the clearness of the picture.

For over-exposed pictures the author recommends the addition of a few drops of a concentrated solution of bromide of potassium to the iron developer, and this does not interfere with any subsequent treatment with cyanide of silver. Evidence of the efficacy of the method is given by the prints of negatives of micro-organisms and of other fresh objects, among which may be mentioned striated muscular fibre in salt solution.

Crookshank's 'Photography of Bacteria' and 'Manual of Bacteriology.'—The intention of Dr. E. M. Crookshank's 'Photography of Bacteria' † will be best explained in his own words:—"It might appear ill timed to publish photographs of bacteria when the apochromatic objectives, which promise to be of such great advantage in photomicrography, have just been introduced. I only wish, however, to illustrate results obtained with ordinary objectives, and to demonstrate that photography may be employed with success to represent preparations of bacteria even under conditions unfavourable for photography. There has been no desire to produce a series of feats in photomicrography; but on the other hand, I am anxious to encourage the attempt to make photography subservient to bacteriology. Those who would aim at the former should select difficult test-diatoms as their subject, and endeavour to equal or surpass the photographs taken by Dr. Woodward, of America.

"The preparations to be photographed were selected without any reference to the staining reagents which had been employed, and in some cases photographs are given which were purposely taken of bacteria so faintly stained, as to be demonstrated under the Microscope with difficulty.

"It is hoped that these photographs will be useful as supplementary illustrations to my 'Manual of Bacteriology,' while the accompanying letter-press may serve as an introduction to the methods employed in photomicrography."

A second edition of the author's 'Manual of Bacteriology' ‡ is also

* Virchow's Archiv f. Path. Anat. u. Physiol., cvi. (1886) p. 502.

† Crookshank, E. M., 'Photography of Bacteria,' xx. and 64 pp., 6 figs. and 22 plates of photographs with explanations, 8vo, London, 1887.

‡ Crookshank, E. M., 'Manual of Bacteriology,' 2nd ed., xxiv. and 439 pp., 137 figs. and 29 pls., 8vo, London, 1887.

issued, enlarged and revised, and with additional chapters on the general Morphology and Physiology of Bacteria, &c. There are seventy-three additional illustrations, and a very extensive Bibliography.

FIELD, A. G.—A new Photomicrographic Apparatus.

Amer. Mon. Micr. Journ., VIII. (1887) p. 94 (1 fig.).

HITCHCOCK, P.—Resolution of pearls of *Amphipleura*.

[Note on Dr. Van Heurck's photographs.]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 105-6.

MAGINI, G.—Qualche considerazioni sulla micro-fotografia. (Some considerations on photomicrography.)

Boll. R. Accad. Med. Roma, 1886, No. 4.

MERCER, A. C.—Photomicrograph versus Microphotograph.

["A photomicrograph is a macroscopic photograph of a microscopic object; a microphotograph is a microscopic photograph of a macroscopic object." The distinction was originated by Mr. George Shadbolt in 1859 or 1860.]

Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, p. 131.

Microphotogrammes du Dr. Van Heurck et du Dr. P. Francotte. (Photomicrographs of Dr. Van Heurck and Dr. P. Francotte.)

[3 of *Amphipleura pellucida* resolved into beads. *Navicula fusca* and Nobert's 18th and 19th band. 4 of zoological subjects.]

Bull. Soc. Belg. Micr., XIII. (1887) pp. 159-60 (1 pl.)

Photomicrography.—See (6) American Society of Microscopists.

(5) Microscopical Optics and Manipulation.

Method of determining the index of refraction when the refracting angle is large.*—The method of minimum deviation can only be employed when the refracting angle of the prism is less than twice the limiting angle; but Signor G. Bartalini shows that indices may be measured in a prism bounded by three planes inclined to one another at two unequal angles, the ray of light being so transmitted as to be refracted at the first and third and internally reflected at the second surface. For the success of this method it is only necessary that the larger angle of the prism added to the complement of the limiting angle should be less than 180° .

The formula is

$$n = \frac{\sin a}{\sin \phi}$$

where

$$\cot \phi = \cot (a - \beta) \cos^2 \theta$$

$$\sin^2 \theta = \frac{\sin b}{\sin a \cdot \cos (a - \beta)}$$

or

$$\cot \phi = \frac{\sin b}{\sin a \cdot \sin (a - \beta) \cdot \cos^2 \theta^1}$$

$$\tan^2 \theta^1 = \frac{\cos (a - \beta) \sin a}{\sin b}$$

According as the ray after internal reflection makes an acute or an obtuse angle with the third surface.

In the above formulæ a and b are the angles of incidence and emergence, and a and β are the corresponding angles of the prism.

Observations made upon a quartz crystal gave—

By minimum deviation $n_o = 1.5442$ $n_e = 1.5537$

By the above method $n_o = 1.5444$ $n_e = 1.5535$.

Resolution of 200,000 lines to the inch.—Once again microscopists have been doomed to a bitter disappointment, which is the harder to bear

* *Atti Soc. Toscana Sci. Nat.*, v. (1887) pp. 181-3 (1 fig.).

from its having been so confidently expected that at last the vapourings of microscopical theorists would be exploded and the superior value of a little practical demonstration clearly shown. Theory might attempt to decide that 200,000 lines to the inch could not be resolved with our present resources, but what could that avail against the fact not merely that 200,000 lines to an inch had been *ruled*, but that they had actually been *seen*.

When it was known that Mr. C. Fasoldt, of Albany, New York, who from all accounts is a most able and skilful ruler of lines, intended to show 200,000 lines to an inch at the last meeting of the American Society of Microscopists, expectation was at fever heat, and the feelings of some of our theoretical microscopists can be better imagined than described. It was evident that it was no longer an occasion for such merriment as followed the statement of the belief of a correspondent that "with a little patience" the feat could be accomplished, nor was the offer now only one to "make affidavits" that the lines had been seen* (as if the question was simply one of veracity), but it was declared that a practical demonstration would be given by the author of the lines in the presence of the members of one of the first microscopical societies of the world. This might well excuse, not only excitement but anxiety, on the part of those who had been pinning their faith on the fact that a good many things must happen before 200,000 lines to the inch can be not merely ruled but seen.

The day came, but alas! with the day the man came not—"circumstances prevented that pleasure." In place of the man came only a ruling and a letter. That the ruling was all it claimed to be we have no manner of doubt; what the letter was can be best appreciated by printing it in full.†

"Albany, N.Y., August 2, 1886.

"Secretary American Society Microscopists.

"Dear Sir,—I had intended to be present at your meeting this month, but circumstances will now prevent that pleasure. With this I send the Society a fine ruling 5000 to 200,000 lines per inch (23 bands). This ruling has been resolved by several persons here, with my vertical illuminator and 1/12 h. im. objective. I had intended to meet with you and display these lines with my apparatus, but that being impossible, I send the lines, hoping that some of the members will be able to see them all as has been done here. I shall always be glad to receive any one interested in rulings, and will display them to any one who will favour me with a visit at Albany.

"Yours very truly, CHAS. FASOLDT."

The only record consequent on this letter is a vote of thanks for the gift, and we have reluctantly therefore been forced to the conclusion that there (whatever had been done "here"), no one was in fact "able to see them all," so that we have a respite, however brief, from that rude awakening which we must nevertheless consider to be still in store for us.

BOYS, C. V.—See "Orderic Vital."

EWELL, M. D.—A further study of centimeter scale "A."

Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 75-82.

"Comparison of a standard centimeter ruled on glass by Chas. Fasoldt, with centimeter scale "A." *Ibid.*, p. 83.

* See this Journal, 1886, p. 868.

† *Proc. Amer. Soc. Micr.*, 9th Ann. Meeting, 1886, p. 206.

GUNDLACH, E.—Optical Errors and Human Mistakes.

Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 157-60.

HEATH, R. S.—A Treatise on Geometrical Optics.

[Contains sections on the Simple Microscope; Coddington lens, Stanhope lens, and Stanhoscope; Doublets of Wollaston, Pritchard, and Chevalier; sketch of theory of telescopes and Microscopes; the Compound Microscope; magnifying power of the Microscope; on the measure of the aperture of the Microscope, *post*; recent improvements in the Microscope.]

xvii. and 356 pp., figs., 8vo, Cambridge, 1887.

HIMES, C. F.—The Stereoscope and its Applications.

[Includes the Binocular Microscope.]

Journ. Franklin Institute, CXXIII. (1887) pp. 398-408, 425-41, 3 pls. and 13 figs.

JAMES, F. L.—

["The Neglected Twin nowhere proves his usefulness more than in microscopy. The observer who has his left hand properly trained has the purely right-handed one at an immense disadvantage. This is especially true in working with high, or comparatively high, powers. Try it, and you will see. With the left hand to manage the stage and the right upon the micrometer adjustment, one can get over a slide in less than half the time occupied when the right hand is constantly leaving the adjustment to regulate the stage."]

St. Louis Med. and Surg. Journ., LII. (1887) p. 348.

KERBER, A.—Bestimmung der Brechungs-exponenten, für welche die chromatische Abweichung zu heben ist. (Determination of the refractive exponents for which the chromatic aberration is to be removed.)

Central-Ztg. f. Optik u. Mech., VIII. (1887) p. 97.

" " Ueber die Korrektur von Systemen grösserer Oeffnung. (On the correction of systems of large aperture.)

Ibid., pp. 145-6.

Magnifying-power of Objectives, Measurement of.

[Inquiry by F. R. Brokenshire and replies by R. Gill, G. H. Bryan, F. J. George, and "Gamma Sigma."]

Sci.-Gossip, 1887, pp. 90-1, 116, and 163-4.

Engl. Mech., XLV. (1887) pp. 392 and 437.

"ORDERIC VITAL."—A lens used both for refraction and reflection, [and note by C. V. Boys.]

Engl. Mech., XLV. (1887) pp. 443-4 (1 fig.), 468.

POLI, A.—[Recent progress in the Theory of the Microscope.]

Rivista Scientifico-Industriale, April 30.

Nature, XXXVI. (1887) p. 262.

ROGERS, W. A.—Methods of dealing with the question of temperature in the comparison of standards of length.

Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 67-74.

ROYSTON-PIGOTT, G. W.—Microscopical Advances. XVIII., XIX., XX., XXI.

[Diffraction, Ancient and Modern.]

Engl. Mech., XLV. (1887) pp. 331-2 (5 figs.), 379 (1 fig.),

427 (4 figs.), 475-6 (6 figs.).

STOKES, A. C.—Focus Upward.

["It has been said in a joking way 'that nothing will throw a microscopist into a chill quicker than to see a friend look into his Microscope and focus downward with his coarse-adjustment.' Yet men who ought to know better have been seen to do this reprehensible thing."]

Queen's Micr. Bulletin, IV. (1887) p. 23, from 'Microscopy for Beginners.'

ZECH, P.—Elementare Behandlung von Linsensystemen. (Elementary treatment of Lens-systems.)

(Sep. Repr.) 16 pp., 8vo, Tübingen, 1887.

(6) Miscellaneous.

Microscopical Society of Calcutta.—A Microscopical Society has, on the suggestion of Mr. W. J. Simmons, been founded at Calcutta,* with an entrance fee and annual subscription of five rupees. It is intended to have two Sessions, one in the cold season and the other in the middle of the year, with a recess after each. Meetings will be held monthly. So far as we know, this is the only Microscopical Society in any part of India. There must be a large and very interesting field for microscopical work in that part of the world, and we wish the new Society every success.

* Indian Daily News, 1887, June 25.

American Society of Microscopists.—The Working Sessions.

- [1. The dredging excursion. 2. Photography (discussion and demonstration of photography by lamplight in its application to the Microscope). 3. The General Session (various exhibitions and practical demonstrations).]

Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 174-96.

"Universal Microscope Screw.

Reports of Committees on Micrometry and on
Ibid., pp. 197-8, 199-201.

BURRILL, T. J.—Presidential Address.

[Bacteria and disease.] *Proc. Amer. Soc. Micr.*, 9th Ann. Meeting, 1886, pp. 5-29.

Dallinger's (Rev. Dr.) Presidential Address.

["Professor Dallinger presents a far more commendable course, as shown in his laborious and conscientious work described in his presidential address before the Royal Microscopical Society. Instead of predetermining that an organism cannot adjust itself to changed environment, because it might follow that species could be evolved from each other, a conclusion at variance with our narrow notion of the way in which an Infinite Creator would proceed in peopling a world with animals and plants, he goes about a series of most delicate experiments, lasting through seven years without a break, to learn if it is a fact that environing conditions may be greatly changed and yet the organism adjust itself to the change. No one can read his account without admiration for such painstaking and intelligent experimentation and for the determination, after the break in the series, to go over the ground again. Such work done by the leaders inspires the rank and file of workers, and it is such work as this which has given us scientific discoveries and their benefits."]

Amer. Mon. Micr. Journ., VIII. (1887) p. 114.

FINK, H. E.—"The Eleventh Commandment in the eye of a needle." (Exhibition.)

The Microscope, VII. (1887) pp. 143-4.

GILMER, T. L.—The Microscope in Dentistry.

Dental Review, 1887, May.

JEAFFRESON, C. S.—Presidential Address to the North of England Microscopical Society.

Eighth Ann. Rep., 27 pp., 8vo, Newcastle-upon-Tyne, 1887.

[MANTON, W. P., AND OTHERS.]—Making a Microscopist.

The Microscope, VII. (1887) pp. 176-8.

MICHAEL, A. D.—Presidential Address to the Quekett Microscopical Club.

[Darwinism.]

Journ. Quek. Micr. Club, III. (1887) pp. 44-62.

Microscopist, an enthusiastic.

[Note on Mr. E. H. Griffith.]

Amer. Mon. Micr. Journ., VIII. (1887) p. 114.

Moore, A. Y., Death of.

[Memorial resolutions of the Cleveland Microscopical Society.]

Amer. Mon. Micr. Journ., VIII. (1887) p. 97.

„ „ Obituary notice of.

The Microscope, VII. (1887) pp. 137-40 (portrait) and p. 149.

Noble, Captain, and this Journal.

[Comment by Editor on note, *ante*, p. 494.]

Eng. Mech., XLV. (1887) p. 402.

Pharmacy, the Microscope in.

[“The Pharmaceutical Society of Brooklyn, in its lectures to drug clerks, includes a course on the Microscope in Pharmacy.”]

The Microscope, VII. (1887) p. 125.

PUMPHREY, W.—The Microscope in the Lecture- and Class-room.

[Concludes that when the object is to demonstrate to a class, or to a small company, who can critically examine the image as displayed on the screen, the image, as taken direct from the object, is much to be preferred; but that for large companies, and where the close examination of the image would be impracticable, the photomicrograph is better adapted to the purpose.]

Journ. of Microscopy, VI. (1887) pp. 141-7.

SORBY, H. C.—The Microscopical Structure of Iron and Steel.

[Paper laid before the Iron and Steel Institute, May 1887.]

The Ironmonger, 1887, June 4, pp. 391-9.

STRASBURGER, E.—Das botanische Practicum. (Practical Botany.)

2nd ed., xxxvi. and 685 pp., 193 figs., 8vo, Jena, 1887.

WARD, R. H.—Remarks on the methods of making Microscopical Societies successful.

Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 94-102.

WEST, C. E.—Forty years' acquaintance with the Microscope and Microscopists.

Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 161-73.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Blood-serum Cultivation.†—Dr. F. Hueppe combines the advantages of blood-serum for growing micro-organisms with the advantages of plate cultivation for separating the colonies in the following manner:—Blood-serum is sterilized at a temperature of 58°–60° by the discontinuous method. It may, however, be sterilized at once and with safety by heating to boiling-point, but although its nutritive properties are apparently unaffected, it loses slightly in transparency. The author gives an illustration of a modification of Fol's sterilizer, heated by the same arrangement as the author's own thermostat.‡ The tubes are laid in the oblique position. After sterilization the serum is warmed to 37° C. and inoculated in the usual manner.

Meanwhile, a 2 per cent. agar solution, to which 0.5–1 per cent. grape sugar is added, has been prepared. Having been fluidified, the agar is cooled down to 42°–45°. Equal quantities of the warm inoculated blood-serum and of the warm agar solution are then mixed together, with the usual precautions, and having been well shaken up, are allowed to solidify in plates, bulbs, &c., at the ordinary temperature. When firm the cultivations are removed to the thermostat. By this method the breeding of tubercle-bacilli from sputum succeeds pretty well.

CROSIER, R.—A method of inoculating fluid cultivating media.

Brit. Med. Journ., 1886, No. 1347, p. 769.

EDINGTON, A.—A new culture medium for micro-organisms capable of withstanding high pressure.

Lancet, 1886, II. p. 704.

GRIESSMAYER.—Die Reinkultur der Microben mit specieller Rücksicht auf die Hefe. (The pure culture of microbes with special reference to yeast.)

Allg. Brauer- und Hopfen Ztg., 1887, pp. 591–2, 603–5.

KOLESSNIKOW.—See Tarchanow.

MACÉ.—Sur la préparation des milieux à la gélose pour la culture des bactéries. (On the preparation of gelatin media for the cultivation of bacteria.)

Ann. Instit. Pasteur, 1887, pp. 189–90.

SMITH, T.—The relative value of cultures in liquid and solid media in the diagnosis of bacteria.

Med. News, 1886, II. p. 571.

STERNBERG, G. M.—Bacteriological Notes. The liquefaction of gelatin by bacteria.

Med. News, 1887, pp. 372–3.

TARCHANOW and KOLESSNIKOW.—Die Anwendung des alkalisch gemachten Eiweisses von Hühnereiern als durchsichtiges Substrat zur Kultur der Bacterien. (The use of alkaline albumen of hens' eggs as a transparent substratum for the culture of bacteria.)

Russkaja Medicina, 1887, No. 11 (Russian).

TERRY, W. A.—Notes on Diatom study.

[Dredging for diatoms.]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 44–6.

VIGNAL, W.—Étude pour Cultures. (Culture oven.)

Ann. Instit. Pasteur, 1887, pp. 184–8.

(2) Preparing Objects.

Method for subjecting Living Protoplasm to the action of different liquids.§—Mr. G. L. Goodall, for studying the action of very dilute solutions on living protoplasm, obviates the necessity of transferring the specimen from the litre-flask, as in the methods of Loew, Bokorny, and Pfeffer, to the stage of the Microscope, by using an apparatus consisting

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 607–10 (1 fig.).

‡ Med. Wochenschr., 1886, No. 17.

§ Amer. Journ. Sci., xxxiii. (1887) pp. 144–5.

of a small number of "chloride of calcium jars," i.e. tall slender jars with an opening near the base, which are connected by means of "three-way" tubes with a common tube of small size. The latter tube is inserted into the side of a microscopic cell made of soft rubber, firmly cemented to the slide and provided with an inflow and an outflow. The object is held beneath the glass cover either by delicate glass floats or by glass threads fastened by wax. When the object is *in situ* the liquid is made to flow by opening one of the cocks or one of the way tubes. The stream of fluid may be made slow or rapid, and one fluid may be substituted for another.

The same apparatus may be used for differential staining, for plasmolytic investigation, and for the cultivation of organisms under different conditions of nutriment.

Modes of preparing Ova.*—Dr. H. Henking, in his investigations into the development of the Phalangida, adopted various methods of preparing the ova; the animals were sometimes killed with boiling water, and left in it for some time for the albumen to coagulate; they were then hardened in successive strengths of alcohol up to 80 per cent. The ova were never placed direct in alcohol, in consequence of the shrinking caused by such a process. Other specimens were killed with ether, the back laid open, and the animals placed in Flemming's chrom-osmic-acetic acid, or in Kleinenberg's picrosulphuric acid for some hours before removal to alcohol. Eggs that had been deposited were treated with hot water, and with Flemming's fluid, as well as with hot and cold chromic acid, picrosulphuric acid, &c. The best staining reagents were found to be Grenacher's borax-carmin, Hamann's neutral acetic acid carmin, and eosin-hæmatoxylin. Before imbedding, the eggs on being taken from absolute alcohol were placed in a mixture of bergamot oil and absolute alcohol, then in pure bergamot oil, and then in a warmed solution of paraffin in bergamot oil, and finally in quite pure paraffin. By the aid of Spengel's microtome sections from 1/80 to 1/150 mm. thick were prepared.

New Method of distinguishing Vegetable from Animal Fibre.†—Dr. H. Molisch's process depends on the application of the two new reactions for sugar lately discovered by the author:‡—About 0.01 gram of the sample, previously well boiled and washed with water, is mixed first with 1 ccm. of water, then with two drops of an alcoholic solution of *a*-naphthol (15–20 per cent.), and finally with an equal volume of concentrated sulphuric acid. In the case of vegetable fibre the solution assumes, immediately after shaking, a deep violet colour, the fibre being dissolved. If, however, the fibre is of animal origin, the liquid assumes a colour varying from yellow to reddish-brown. By substituting a solution of thymol for *a*-naphthol a fine carmine colour is obtained in the place of the violet.

The author has successfully applied this test to different vegetable fibres, such as cotton, hemp, jute, china-grass, &c.; also to the cellular tissues of wood, cork, and fungi. Moreover, in the case of dyed fabrics the colouring matters do not appear to interfere with the success of the reaction.

Mode of examining Mucous Membranes.§—Prof. L. Ranvier describes the following method of studying the membrane which invests the retro-lingual sac of the edible or the grass-frog. The membrane is detached and then extended on the disc of Ranvier's moist chamber in such a

* Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 88–90.

† Dingler's Polytech. Journ., cclxi. (1886) pp. 135–8. Cf. Journ. Chem. Soc. Lond., Abstr., 1886, p. 1088.

‡ See this Journal, *ante*, p. 344.

§ Comptes Rendus, civ. (1887) pp. 819–20 (1 fig.).

way that its epithelial surface is turned upwards. During this operation desiccation of the tissues is avoided by sprinkling them with aqueous humour, blood-serum, or chloride of sodium in 7/1000 solution; the membrane is maintained in a state of extension by a ring of platinum which is fixed on the disc of the moist chamber; the ring must be of a little longer diameter than that of the disc, in order that the membrane may be held between it and the disc. The membrane is covered by a glass plate, which is fixed with paraffin. In such a preparation the cells with vibratile cilia, sensory or glandular cells, striated muscular fibres, and nerve-fibres and cells may be easily observed in the living state. As the ring keeps the membrane in its place, the glass cover may be removed for the purpose of adding reagents.

Investigating the Termination of Nerves in the Liver.*—Mr. A. B. Macallum adopted the following method for demonstrating nerve-structures in the liver of *Necturus* (= *Menobranchus*). Pieces of the liver were hardened for a week or more in Erlicki's fluid, or for several days in a 1/6–1/5 per cent. solution of chromic acid. After the hardening was sufficiently completed in alcohol, sections of the frozen tissue were made with a Cathcart microtome. When the gum was carefully removed these were put in a 5 per cent. solution of formic acid for an hour, transferred to a 1 per cent. solution of gold chloride for about twenty minutes, then washed in distilled water, and the gold afterwards reduced in the dark with a 10 per cent. solution of formic acid. About thirty hours suffices for this reduction at a temperature of 20° C., and the sections then have a deep red colour, though the tinge was sometimes violet. The chromatin of the nuclei of the hepatic cells took a deep blue-violet tint, the caryoplasm light violet, while the cytoplasm came out very distinctly as a meshwork with a pink or light carmine colour; the nerve-fibres appeared deep violet, but the connective tissue of the interlobular spaces attained a light, or sometimes a deep red colour. When chromic acid was used as a hardening reagent the addition of any organic acid at the same time, such as acetic acid more especially, seemed to have the effect of robbing the nerve-fibres of their selective capacity for gold. Sections of the liver of *Necturus* are of no value when they are less than 0.02 "m" [mm.] in thickness. With the human liver preparations proved to vary very considerably, but were often not successful.

All the sections were cleared in oil of cloves and mounted in balsam. The study of the ultimate terminations of the nerves was made with the Leitz 1/12 in. homogeneous immersion, with special illumination.

The author discusses the value of gold chloride as a reagent for differentiating nerves, which is not admitted by all histologists; he thinks that it has many advantages over other reagents; the substance which fixes the gold in a violet form is not confined to nerves, but appears to be diffused to a small degree in other tissue elements; the failures of some histologists are referred to their not having sufficiently hardened the tissues. Osmic acid, although useful in the case of medullated nerve-fibres, is of no value for demonstrating the finest non-medullated fibrils.

Preparing the Amphibian Egg.†—Prof. O. Schultze has found that for hardening-fluids the following mixtures give perfectly satisfactory preparations when used in the manner described below:—(1) *Chromo-osmio-acetic Acid*: Chromic acid (1 per cent.) 25 parts; osmic acid (1 per cent.)

* Quart. Journ. Micr. Sci., xxvii. (1887) pp. 443–8.

† Zeitschr. f. Wiss. Zool., xlv. (1887) p. 185. Cf. Amer. Naturalist, xxii. (1887) pp. 595–6.

10 parts; water 60 parts; acetic acid (2 per cent.) 5 parts. (2) *Chrom-acetic Acid*: Chromic acid (1 per cent.) 25 parts; acetic acid (2 per cent.) 5 parts; water 70 parts.

The eggs are left in one of these fluids twenty-four hours, then washed in distilled water, which should be often changed. The egg-envelopes are next removed by the aid of needles, and the eggs are then ready for surface-study.

For the purpose of sectioning the eggs are transferred from the water used in washing to 50 per cent. alcohol, then to 70 per cent., 85 per cent., and 95 per cent., leaving them twenty-four hours in each grade. The last grade should be changed several times. The eggs are then clarified in turpentine one to two hours, and then placed in paraffin that melts at 50° C. from one-half to one hour.

Prof. Schultze states that the success of the method depends on following precisely the directions given as to time. If the eggs remain longer, either in alcohol, turpentine, or paraffin, the results may be entirely unsatisfactory. If the conditions are strictly followed the eggs have the consistency of the paraffin, and cut excellently without crumbling in sections 1/200 mm. thick.

For staining, borax-carminé was used, directly after washing, twenty-four hours. The eggs were next placed in acid alcohol of 70 per cent. (five drops of the pure acid to 100 ccm. of the alcohol) to remove a part of the colour.

The first hardening fluid does not penetrate well, and is not well adapted for fixing the central parts of the egg.

Preparing Eyes of Molluscs and Arthropods.*—Mr. W. Patten's methods for preparing the eyes of Molluscs and Arthropods are as follows:—

I. MOLLUSCS (preparation of young *Pecten* from 1–3 mm. long).—

(1) Specimens are placed in a mixture of equal parts of sublimate and picrosulphuric acid. After ten or fifteen minutes they are washed in 25 per cent. and 70 per cent. of alcohol.

(2) The shells are then opened, and the mantles dissected out with needles. Thus treated, the shape of the mantle is well preserved, whereas if removed before hardening it becomes much coiled and twisted.

(3) Each mantle edge may be cut, according to its size and curvature, into three or four pieces, and these will then lie sufficiently straight for convenient sectioning.

It is necessary to use a different reagent for nearly every part of the eye.

The Rods.—Chromic acid gives the most varied results according to the strength, time of action, and temperature of the solution, or by various combinations of these three. For instance, 1/20 to 1/5 per cent. for thirty to forty hours failed to give any conception of the structure of the rods, while other parts of the retina, and of the eye itself, were well preserved; but when allowed to act for half an hour at a temperature of from 50° to 55° C., perfectly preserved rods with their nervous networks are obtained, whilst, on the other hand, the remaining tissues become so granular and homogeneous as to be unfit for study. This treatment allows the rods to be removed in flakes, and their ends examined without the aid of sections. It is only in this way that the axial nerve-loops can be observed.

* MT. Zool. Stat. Neapel, vi. (1886) pp. 733–8. Cf. Amer. Natural., xxi. (1887) pp. 401–4, and this Journal, ante, pp. 53 and 82.

The Lens.—The lens is best prepared for sections by either sulphuric or picro-sulphuric acid; by the first reagent its shape is best retained, and the lens itself is less liable to be drawn away from the surrounding tissue; the latter reagent, however, brings out more sharply the configuration of the cells, and allows a better stain of the nuclei to take place.

The Retinophoræ.—The retinophoræ are well preserved by nearly all the reagents; but in sublimate, in picric acid, or in their combinations, they become slightly granular, and remain so closely packed that it is difficult to distinguish the cell boundaries. Chromic acid $1/5$ per cent. for three or four days, contracts the cells and gives preparations in which the boundaries and general arrangement of the retinophoræ are easily studied.

Section of the Eye.—In order to obtain the best sections of the adult eye with all the parts in the most natural position, it is necessary to treat them first with $1/10$ per cent. of chromic acid for half an hour, then in $1/20$ per cent. for twenty-four hours; $1/10$ per cent. for twenty-four hours, and finally $1/5$ per cent. for forty-eight hours or more. Next to this method, it appears that solutions of sulphuric acid (twenty drops to fifty grammes of water) give the best preparations (for sectioning) of everything except the rods.

The double layer of the sclerotica and the fibres penetrating it can be seen in sections of eyes treated twenty-four hours in $1/5$ per cent. chromic acid.

Maceration and Dissection.—The pigmented epithelial cells of *Pecten's* eyes and the cells of the cornea are easily isolated by treatment with Müller's fluid or bichromate of potash $1/2$ per cent. for two or three days. For the maceration of all other elements weak chromic or sulphuric acid is used. For the outer ganglionic cells, which are very difficult to isolate, maceration in $1/50$ per cent. chromic acid gives excellent results, after previously fixing the tissue in $1/5$ per cent. for a few minutes.

For the retinophoræ, $1/20$ per cent. for four or five days proves very useful.

Sulphuric acid 5 drops to 30 grammes of sea-water gives the best results for the nerve-endings in the retinophoræ (not in the rods), and for the nervous inner prolongation of the outer ganglionic cells.

In order to isolate pieces of the cornea with the subjacent *pseudocornea* and the circular fibres on the outer surface of the lens, it is better to macerate the eyes in sulphuric acid as given above. The same treatment retains to perfection the natural shape of the lens, which may then be isolated, and its surface studied to advantage.

It is necessary for the study of the *circular retinal membrane*, the *septum*, and the *retina* itself, to isolate the latter intact. Maceration in chromic acid either makes the retina too brittle or too soft, while the axial nerve-fibres remain so firmly attached to the retina that it is difficult to isolate it without injury. But this may be easily and successfully done by maceration for one or two days in the sulphuric acid solution. By this treatment the *retina*, together with the *septum* and *circular retinal membrane*, may be detached entire.

Surface views of the retina show the peripheral outer ganglionic cells. The *argentea* may be very easily separated in large sheets by macerating for four or five days in bichromate of potash of 1 per cent.

Sulphuric acid is a most valuable macerating as well as *preservative reagent*. In weak solutions (40 drops to 50 grammes) entire molluscs, without the shell, have been kept in a perfect state of preservation for more than six months. For cilia and nerve-endings it is exceptionally good.

The eyes of *Arca* and *Pectunculus* may be macerated either in Müller's

fluid or chromic acid. Undiluted Müller's fluid in twenty-four hours gives more satisfactory preparations than a weak solution which is allowed to act for a longer period. Chromic acid 1/5 per cent. for ten or twelve days gave most of the preparations from which the drawings of the nerve-endings in the author's paper were made. A few drops of acetic and osmic acid added to distilled water gave a very energetic macerating fluid for the epithelium of marine molluscs. Such preparations led to the discovery of the very delicate outward continuations of the pigmented cover-cells in the compound eyes of *Arca*.

II. ARTHROPODS.—In order to demonstrate the presence of the *corneal hypodermis* in the faceted Arthropod eye, and the connection of the so-called "rhabdom" with the crystalline cone cells, it is necessary to resort to maceration. In most cases it is hardly possible to determine the important points by means of sections alone.

The ommatium of fresh eyes, treated for twenty-four hours or more with weak sulphuric or chromic acid, or in Müller's fluid, may be easily removed, leaving the corneal facets with the underlying hypodermis uninjured. Surface views of the cornea prepared in this way show the number and arrangement of the corneal cells on each facet. In macerating the cells of the ommatium it is not possible to give any definite directions, for the results vary greatly with different eyes, and it is also necessary to modify the treatment according to the special point to be determined. It is as essential to isolate the individual cells as it is to study cross and longitudinal sections of the pigmented eyes. In determining the number and arrangement of the cells and the distribution of the pigment, the latter method is indispensable; it should not be replaced by the study of depigmented sections, which should be resorted to in special cases only.

In *fixing* the tissues of the eye, it is not sufficient to place the detached head in the hardening fluid; antennæ and mouth-parts should be cut off as close to the eye as possible, in order to allow free and *immediate* access of the fluids to the eye. When it is possible to do so with safety, the head should be cut open, and all unnecessary tissue and hard parts removed. With abundant material, one often finds individuals in which it is possible to separate, uninjured, the *hardened* tissues of the eye from the cuticula. This is of course a great advantage in cutting sections. The presence of a hard cuticula is often a serious difficulty in sectioning the eyes of Arthropods. This difficulty can be diminished somewhat by the use of the hardest paraffin, and by placing the broad surface of the cuticula at right angles to the edge of the knife when sectioning. Ribbon sections cannot be made with very hard paraffin, but it is often necessary to sacrifice this advantage in order to obtain very good sections.

Killing Polyzoa.*—Mr. T. Whitelegge writes:—"I place a small twig of Polyzoa in about two or three drachms of water; when fully expanded I add about two drops of chloroform, and these should be dropped in so that they sink to the bottom. In from a quarter to half an hour I add spirits, about six drops at a time, and stir up gently, so that it gets mixed with the water. The spirits and chloroform stupefy them, and I try touching one to see if they are in a *sleepy* condition; then I add more spirits gradually, mixing it and the water each time. When the fluid consists of equal quantities of water and spirit, I let them stand for a time, then add spirit very cautiously till they are in nearly pure spirit. This is necessary, as they contract, even after death, if the water is extracted from them too rapidly. When they are killed they should on no account

* Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 30-1.

be *lifted* out of the vessel, but floated from one vessel to another. If they are *lifted* out the tentacles become disarranged, and cannot again be put right."

Preparation of Insect Spiracles.*—Mr. F. Dienelt remarks that in most beetles the spiracles are found on the upper part of the abdomen. The insect should be turned on its back and cut across the thorax close to the abdomen; then turn again, and insert a sharp knife into the opening made, and cut round the whole abdomen. As soon as there is room, insert a small stick of soft wood sharpened to a flat point, by means of which the object can be held securely while cutting. All the cutting should be done on the lower side, so that a margin is left on the upper part, which can be trimmed easily after the object has become softened in liquor potassæ. Steeping the insect in this fluid for a couple of hours will destroy all the viscera. Now, hold the part down with the pointed stick, which for this purpose is far superior to mounting-needles, and with a camel-hair pencil remove the viscera and transfer the object to rain-water, removing this two or three times to insure cleansing and to remove the last trace of potash. Keep on brushing until it is certain that the object is clean, and then trim the edges to suit before a final washing. If it be desired to mount the tracheæ *in situ*, greater care is necessary in treating, but they show very well through the skin. Or after most of the viscera have been removed, the tracheæ can be torn by a sawing motion with the back of the knife from the spiracles and mounted separate. In mounting larvæ entire, they should be left in liquor potassæ for a longer time; even a whole day without injury. In cleaning, it is necessary to keep them in the position in which they are to be mounted. Larvæ of the Lepidoptera show best when mounted on the side. In preparing these, hold the larva under water with the pointed stick, and clear out the viscera with a brush through the anal opening by a rolling motion. After a start has been made the process takes but a short time. Larvæ will stand considerable pressure in cleaning, but gentle manipulation of course answers best, especially in those covered with hair. It is best to commence with the largest beetles or larvæ one can find. Larvæ too large to be mounted entire ought to be opened along the back to give the liquor free access.

Twenty-seven grains of potassa fusa to one ounce of water acts but slowly on the chitinous parts of insects, but very promptly on the viscera. It is best kept in a paper-covered bottle, to exclude the light.

Botanical Manipulation.†—M. P. Girod's 'Manipulations de Botanique' treats, in the first place, of the methods of using the Microscope, reagents, &c. The rest of the work consists of a series of original diagrams illustrative of the histology and anatomy of typical plants, from Dicotyledones to Algæ, ending with cell-tissue for purpose of comparison with unicellular organisms. Short notes explaining the methods of preparing sections accompany the plates.

Preparation of Plants in Alcohol.‡—M. H. de Vries explains the great brittleness imparted to fresh parts of plants by plunging them in alcohol in the following way:—The alcohol penetrates first into the outer, and only gradually into the inner, layers of tissue. While the outer cells are killed, the inner cells still retain all their turgidity. These inner still living cells prevent the contraction of the cell-walls in the outer layers, and the latter become, therefore, hardened while still in the stretched condition. While

* The Microscope, vii. (1887) pp. 102-3.

† Girod, P., 'Manipulations de Botanique,' 72 pp. and 22 pls., Svo, Paris, 1887.

‡ Maandbl. v. Natuurwetensch., 1886. See Bot. Ztg., xlv. (1887) p. 31.

this process is advancing from without inwards, the inner cells also die, and the contraction of their walls is prevented by their connection with the outer layers which have already become stiff; and they also become hard while in the stretched condition. The brittle tissues can be softened by soaking in water for from half an hour to an hour, and do not then again become brittle if again placed in strong alcohol.

Cleaning Diatoms.*—Mr. W. A. Terry recommends the following process for cleaning diatoms. No fumes of any consequence are given off, no artificial heat is required, the process takes only a few minutes, and a much larger proportion of the diatoms are uninjured:—

After washing out the coarse sand and straining out the coarse refuse from the gathering which has not been dried, the material is allowed to settle in the vessel; the water is then poured off rather closely, so that the amount remaining shall be about equal in weight to the weight of the material dry. Finely powdered bichromate of potash is then added in amount equal to the estimated amount of organic matter in the material exclusive of the sand. It is then stirred until mixed; for this purpose a glass slip half an inch wide, with rounded edges, is more convenient than a glass rod. Strong commercial sulphuric acid is then dropped in until brisk effervescence is set up, and continued until the acid produces no effect. The whole mixture is then poured into a vessel containing cold water, and after agitation is allowed to settle. The diatoms will now be found to be nearly clean, and only require the usual alkaline treatment and thorough washing. After the addition of the bichromate, the temperature of the material and of the acid should not be less than 70° F. If the diatoms be not sufficiently cleaned, the operation may be repeated or nitric acid used without much danger. If the material have been dried, it will be well to soak or boil it in water before using acid. Marine muds should be first washed in fresh water to remove the salt, and as they contain more refractory material, the action should be proportionately energetic. Fossil marine earths should be thoroughly softened by long soaking and boiling before being treated with acids, otherwise the gases disengaged would tear and fracture very many of the forms. Boiling in alkalies should be avoided, if possible, as many varieties are softened and distorted by even cold and weak solutions. As first washings, both acid and alkaline, settle very slowly, they should be allowed plenty of time, otherwise the lighter and more delicate varieties would be lost.

The author states that he usually succeeds in getting the diatoms beautifully white and clean at the first operation, but admits that the process is capable of some improvement.

Preparing Silver Crystals.†—Mr. F. T. Chapman says that artificially prepared silver crystals make fine opaque objects, either as permanent mounts, or for observing the process of crystallization. They may be readily prepared, although some care is necessary in order to obtain the best results, especially if the preparation is designed to be permanent.

The deposition of silver from a solution of silver nitrate by means of copper, preferably a copper-wire ring placed in a sufficiently deep cement cell, gives very good results if the wire ring and the thicker mass of crystals at the edge be removed, and the specimen then thoroughly dried and protected by a cover-glass in the usual way. Much better results, however, can be obtained with a brass cell provided with a removable cover or cap (known as the "Pierce cell"), and cemented to a glass slip, the cell being

* Amer. Mon. Micr. Journ., viii. (1887) pp. 69-71.

† Ibid., pp. 99-100.

backed by dark-coloured wax. When filled with the solution, the deposition of silver crystals on the inner surface of the cell will immediately commence and proceed slowly toward, but should not be permitted to reach, the centre. When the crystals have approached so near the centre as to leave a clear space of about $1/8$ in. in diameter, the solution should be removed by means of a small piece of blotting-paper placed on top of the cell and allowed to remain for a moment. The strength of the solution is not important, but should not be very weak, as the feathery masses of crystals that add greatly to the beauty and depth of the mount do not then appear.

If the crystals, when forming, appear white and brilliant, or darken slightly, or appear to be very fine or small at the sides of the cells, while those at the bottom are spray-like and quite large, the result will usually be successful, although the best conditions are when the bottom of the cell is occupied by several large feathery sprays of crystals, and the sides by shorter sprays or spine-like crystals, the whole being white and brilliant. Sometimes, after the solution has been removed, a deposition of copper on the silver will be found, or crystals of copper salts will intermingle with the silver, and mar its appearance, in which case it is necessary to reprepare the mount. If the silver be permitted to reach the centre, a black precipitate will form and spoil the preparation as a permanent mount, but as the fluid is then filled with a mass of minute sparkling crystals in constant motion, the effect is both interesting and beautiful when viewed with a power of about twenty-five or fifty diameters.

The time usually occupied in preparing a silver mount is about five minutes, the preparation being completed when the solution is removed from the cell by the blotting-paper.

If the crystallization of the silver be unsatisfactory, the cell may be readily cleaned and another layer of wax applied. In order to apply the wax to the cell, a sheet is placed on the cell, pressed slightly with the finger, and a disc of wax forced into the cell by means of a cork that will snugly fit it, sufficient pressure being applied to cause the wax to adhere to the glass slide or to the wax already in the cell.

There seems to be no rule by which the deposition of the crystals can be regulated, as under apparently the same conditions one preparation will be successful and the next one will be a failure. It would seem that a small quantity of gum in the solution would cause the crystals to adhere, and prevent them from breaking or shaking loose when the slide is handled roughly. Gum arabic has been tried without success, as it causes the crystals to turn black. However, the crystals usually adhere firmly enough to the cell and to each other to stand all ordinary usage. A greater mass of crystals may be obtained by repeating the deposition in the same cell, and allowing one mass of crystals to form on the top of the other. When forming in the solution, the crystals seem to almost completely fill the cell, standing out laterally, but when the fluid is removed they fall to the bottom and appear to the eye to form a thin layer, but under the Microscope they stand out in bold relief.

Preparing Crystals of Silicon Fluoride.*—Beautiful objects for polarized light are produced by the action of undiluted fluoric acid on an ordinary glass slide, the results varying with the composition of the glass acted upon. The best results are to be obtained by using slips of thin polished plate and the following process:—Cut a circular hole in a piece of sheet modelling wax; warm the slide slightly, and make the wax adhere

* *Scientif. Enquirer*, ii. (1887) pp. 128-9, from 'Dental Record.'

well to it, so as to form a fluid-tight cell. Into this put four or five drops of the acid; watch its action closely when the glass has acquired an opaque film, which will be in from three to five minutes; wash it with a stream of warm water; finish with a camel-hair pencil. Remove the wax and dry the slide. The result shows crystals of silicon fluoride, which require no mounting.

Blood, permanent Preparations of.

[Method taught in Heidelberg.]

The Microscope, VII. (1887) p. 115.

BRAMWELL, R.—Process for the detection of micro-organisms in nerve-tissue.

Edin. Med. Journ., 1886, p. 324.

CASSELLARNAU, J. M. DE.—Procédés pour l'Examen microscopique et la Conservation des Animaux à la Station zoologique de Naples. (Methods for microscopical examination and the preservation of animals at the Naples Zoological Station.)

Journ. de Microgr., XI. (1887) pp. 183-6, 215-7, 447-53.

FELLOWS, C. S.—Collecting, dissecting, and mounting Entomostraca.

Proc. Amer. Soc. Micr., 9th Ann. Meeting, 1886, pp. 186-8.

MARTIN, L. J.—Petroleum Spirit as a Plant Preservative.

[Recommends petroleum spirit (boiling from 25°-45° C.) for preserving plants intended for the study of chemical constituents.]

Bot. Gazette, XII. (1887) p. 42.

MILES, J. W. L.—The capturing, killing, and preservation of Insects for microscopical purposes.

Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 80-1.

PARKES, R.—The preparation of Foraminifera from common chalk.

Trans. and Ann. Rep. Manchester Micr. Soc., 1886, p. 21.

(3) Cutting, including Imbedding and Microtomes.

Ryder's Paraffin Imbedding Apparatus.*—Prof. J. A. Ryder describes a new paraffin imbedding apparatus which he has designed.

Those who have had much experience in imbedding in paraffin are aware of the difficulties and risks which attend the imbedding of delicate objects on account of the danger of overheating the imbedding mass. The trouble with thermostats, or heat-regulators, is that they get out of order and give trouble, apart from the difficulty which arises from the variations in the pressure of the gas in the pipes which supply the burners, and which is entirely beyond the control of most forms of the thermostat. To avoid this, Dr. C. S. Dolley, of the Biological Department of the University of Pennsylvania, began a series of experiments with copper bars, which were heated at one end by means of a Bunsen burner, so that the heat conveyed by conduction to the remote end of the bars gradually diminished in intensity, because of its being constantly radiated into the surrounding air, according to well-known laws stated in the text-books on physics. It was found that, with the room at an approximately constant temperature, there was a point along the bar, at a certain constant distance from its heated end, where the temperature of 55° C. could be maintained, and where, if there was placed a copper cup filled with hard paraffin, the latter could be kept just at the point of fusion for a long time without endangering the objects to be imbedded. These results showed that it was possible to utilize an apparatus of this type for imbedding purposes.

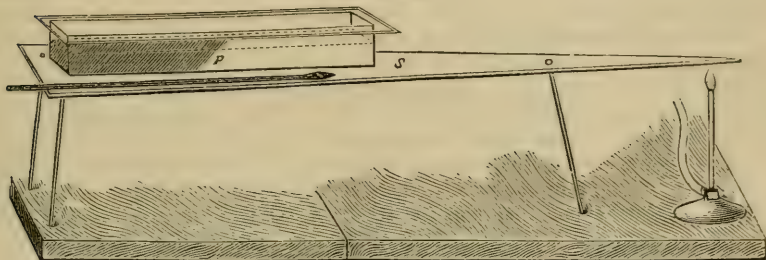
This led the writer to begin a set of experiments with a very simple modification of the foregoing type of apparatus, with the object of getting rid of the usual water-bath entirely in the process of imbedding, and to also use the paraffin itself as a means to indicate how far away from the source of heat it would be safe to allow an object to remain while it was being saturated.

The object was effected in the following manner:—A triangular sheet

* *Amer. Naturalist*, xxi. (1887) pp. 597-600 (1 fig.).

of copper, slightly less than $1/16$ in. thick, 18 in. long, and 10 in. wide at one end and running to a sharp point at the other, as shown at *s* in fig. 190, is supported horizontally upon two legs at the wide end, and at some distance from the pointed end by another leg, these three legs constituting a firm tripod base for the whole device. Under the pointed end of the triangular plate of copper is placed a small Bunsen gas-burner, with an aperture of about $1/8$ in., and connected with the gas-supply of the building by means of a rubber tube. If the flame is allowed to burn

FIG. 190.



steadily at about half its full force, and permitted to play upon the copper plate at a distance of about 1 in. from its extreme point, as shown in the figure, the whole plate will soon be heated, but the temperature will be found to gradually diminish towards the wide end. At a distance of about 12 to 13 in. from the point where the flame acts upon the copper plate the temperature will remain steadily at about 56° C., with the temperature of the room at 22° C. As long as the temperature of the room remains nearly the same the temperature of the plate at any given distance from the burner will also remain at the same point. This constancy is due to the fact that the heat which is conducted through the copper plate with constant rapidity from its source—the burner—is radiated into the surrounding air at an equally constant rate, and as one passes towards the wide end of the plate from the burner, trials with the thermometer show that there may be found an infinite number of points in succession at which the temperature is very nearly constant.

In order to use the paraffin itself as an indicator of the proper temperature, and in that way dispense with the thermometer altogether if desirable, it was necessary to use a new type of cup in which to melt the paraffin. The paraffin-cup or trough *p* shown in the figure is made of copper, tin-lined, and is 6 in. long, $1\frac{1}{2}$ in. wide, and $1\frac{1}{4}$ in. deep. In practice the cup is half filled with paraffin and placed lengthwise on the copper plate, with its narrowest side towards the flame, and about 9 in. from it, as shown in the cut. The paraffin-cup may be covered with a slip of glass to exclude dust. If the burner plays upon the plate as directed, and the trough is in the proper position, in about an hour it will be found that the paraffin in the trough has been melted at the end nearest the burner but has remained congealed at the other. Moreover, it will be found that the point where the melted comes in contact with the nearly frozen paraffin is very constant, and it is just at this point where it is safe to place objects which are to be imbedded. The paraffin which remains congealed in the trough is represented in the cut by the shading at the remote end of the trough, the clear space below the dotted lines nearest the flame indicating the portion which remains molten.

It is clear from what has preceded that a shorter cup or trough filled with soft paraffin melting at 36° C. may be placed still farther away from the burner, alongside of the vessel containing hard paraffin fusing at 56° C., while mixtures of turpentine and paraffin, or chloroform and paraffin, would remain molten at a still greater distance from the flame.

The applications and possibilities of this new device will be readily appreciated by histologists and embryologists, since it can be quickly seen if objects are in danger from overheating by simply noting whether the point where the paraffin remains molten in the trough has advanced farther from the flame. This can be easily observed through the transparent cover of the trough.

For large laboratories, where a number of students are engaged in imbedding, a simple modification of this device suggests itself. For such a purpose a horizontal disc of sheet copper, of the same thickness, but 3 ft. in diameter, would afford room for a large number of paraffin imbedding-troughs, which could be arranged in a circle around and some distance from the centre, at which point a larger burner would be applied underneath. The temperature in such a device would diminish from the centre towards the periphery of the disc. The troughs would be placed upon different radii upon the surface of the disc, just as two or three troughs may be placed upon different radii of the triangular plate, which is practically the sector of a disc, as described above.

For imbedding delicate objects, small cups made of tin-foil, pressed into shape in circular tapering moulds, may be satisfactorily employed with this apparatus, in the same way as the troughs.

The device described above can be made by any coppersmith for about two dollars.

Imbedding Objects for the Rocking Microtome.*—Herr S. Schönland advises the following method for imbedding objects in paraffin. It is especially intended for use with the Cambridge rocking microtome, which requires perfect saturation of the object with paraffin. The object, first stained in borax-carminé, is placed in 30 per cent. spirit, to which a trace of acetic acid has been added. It is then transferred to stronger and stronger spirit. From the strongest alcohol it is transferred to a vessel (holding 3–4 cm.) half filled with oil of cloves and half with spirit. When the specimen has sunk to the bottom, it is placed in pure cloves, and after an hour in turpentine oil, wherein it remains for about six hours. It is next immersed in paraffin for eight to ten hours. The temperature of the paraffin, which has a melting-point of about 45° C., is not allowed to rise above 47° , but just before imbedding it is advisable to heat the paraffin a little more, as air-bubbles are thereby avoided. The ordinary paper boxes are used for imbedding.

Imbedding Eyes in Celloidin.†—Dr. W. B. Canfield recommends that eyes should be hardened in Müller's fluid and then after-hardened in spirit. Schultze's diffusion apparatus is of great use for preventing shrinking of the eye. A small incision is then made tangentially to the sclera and also on the corneal edges, and the eye put in equal parts of absolute alcohol and sulphuric ether. After twenty-four hours it is transferred to pure ether, and the next day to a thin watery solution of celloidin in ether. In order to get rid of air-bubbles, the eye is to be so immersed that the incisions are uppermost. After twenty-four hours the eye is put in thick celloidin, the vessel being left partially uncovered, until the celloidin is hard enough to

* Bot. Centralbl., xxx. (1887) pp. 283–5.

† The Microscope, vii. (1887) pp. 99–101.

be cut. The block is then cut out, softened a few minutes in absolute alcohol, dipped once more in the celloidin solution, and put on a cork.

The block when cut out is better softened in ether and at once transferred to the cork. This procedure is not only more simple but more effective. The preparation on the cork is then exposed to the air until quite stiff and then allowed to float in 84 per cent. spirit until required. By this method sections of the whole or any part of the eye may be made. Anilin colours are to be avoided as they stain the celloidin. Logwood also stains it, but acetic acid (1/2-1 per cent. solution) withdraws it in twenty-four hours, leaving the tissue still coloured. Rosin may be used as a contrast stain. Cedar and origanum oils are the best for clarifying.

Imbedding in Vegetable Wax.*—Dr. P. Francotte who has recently investigated the qualities of vegetable wax as an imbedding medium, finds, that whatever its potentialities may be, it is inferior to paraffin. The method he advises is as follows:—After the object is fixed, hardened, and stained, or not, it is laid in 94° spirit, kept at a temperature of 48° C. in a water-bath. The wax is then added gradually, and in small pieces, until the consistence is that of soup. If the object be small, the heat is continued until all the alcohol has evaporated. If the object be large, the alcoholic mass and the object are poured into a bulb fitted with a straight cooler or tube, about three feet long; as the spirit condenses, it falls back into the bulb, and when the object is properly saturated it is removed to another vessel and the spirit driven off. The object is then oriented in a metal or cardboard box filled with warm wax. When cool, the mass may be cut with a microtome or by hand. The sections are fixed to the slide with albumen or gum. The slide is then heated in a water-bath to 50° C., and alcohol added until the wax is dissolved. If not coloured *en masse*, the sections may now be stained and then dehydrated, and afterwards cleared up in cloves, cedar, or bergamot oil, or they may be mounted in glycerin.

The advantages this medium has over paraffin are, that it dispenses with such fluids as toluol, xylol, benzine, and chloroform, and hence is suitable for animal tissue where these fluids are contra-indicated. It is available also for the examination of micro-organisms in tissues; in this it is superior to paraffin, for it is always difficult and frequently impossible to discover microbes in tissues impregnated with paraffin. Its most important disadvantages are, that it is difficult to obtain sections thinner than 0.01 mm., and to make out when the object is properly saturated.

Baskets for the suspension of objects in paraffin.†—Mr. H. Garman recommends the use of wire baskets for suspending objects in paraffin. Such a basket is easily made by coiling annealed wire as shown in fig. 191, beginning at the centre of the bottom and working outwards to the margin, then making the handle *h*, and finishing with a triangular base *b*. In use it is placed in the melted paraffin, the triangular base supporting and keeping it from the bottom of the paraffin basin, and it can be removed by means of the projecting handle, which is made of such length that it does not interfere with the glass cover of the basin. For very small objects a hammered wire spoon, like that used by Dr. Mark, is mounted in the same way as the basket (fig. 192). This method of suspending objects in paraffin

* Bull. Soc. Belge Micr., xiii. (1887) pp. 140-4.

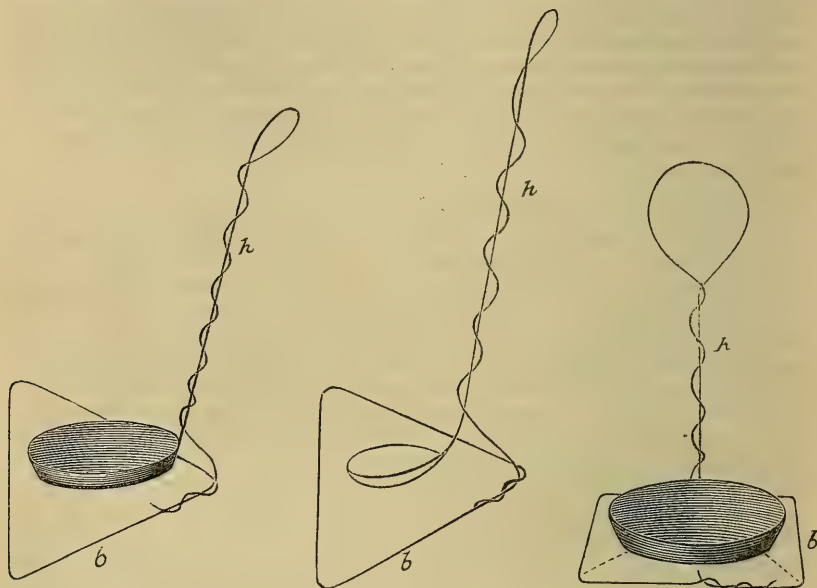
† Amer. Naturalist, xxi. (1887) pp. 596-7 (3 figs.).

has resulted from attempts to avoid long handles or other belongings of the baskets, that prevent the close fitting of the plates of glass used to cover the paraffin dishes.

Fig. 191.

Fig. 192.

Fig. 193.



Francotte's Sliding Microtome.*—Dr. P. Francotte has designed an instrument capable of making most perfectly regular sections of a limited size, 5 mm. at most. The body of the microtome is like Ranvier's, and the object to be cut is placed in a cylinder which slides in the microtome tube. The latter piece does not rub against the metal walls, but is supported in the cylinder by means of pieces of cork. At the base of the tube is a scale for noting the movements of the screw, and at the side is an index for showing in what limits the piece can move.

Upon the circular table of the microtome is fixed by three screws a plate larger than the table. In the centre is an opening in order that the piece may be raised, and at the side a groove with triangular vertical section and sharp edges; within this groove the object-carrier runs. The carrier slides merely on two longitudinal bands so as to lessen the friction as much as possible. The groove maintains a rectilinear and regular movement; the two metal bands keep the knife moving in the same plane. The razor is fixed to the carrier by means of a metal piece and two screws, and in order to obtain the desired stability the instrument is fixed to the work-table by a binding screw. For the rest, the manipulation of the instrument is very simple, and M. Francotte thinks it will suffice for most histological investigations.

Ryder's Automatic Microtome.†—This instrument (figs. 194 and 195) has been devised by Prof. J. A. Ryder, in order to facilitate the preparation

* Bull. Soc. Belge Micr., xiii. (1887) pp. 149-50.

† Amer. Natural., xxi. (1887) pp. 298-302 (2 figs.). Cf. also The Microscope, vii. (1887) pp. 179-83 (2 figs.).

of sections for large classes, and also for the rapid preparation of series of sections in ribbons in embryological work, in which the element of time becomes a serious consideration. One hundred sections per minute can be readily cut with it.

The device is small and compact and is also automatic; the cutting takes place as fast as it is possible to move a vibrating lever up and down through a distance of 3 in. with the right hand. The designer considers that "nearly all other automatic microtomes are costly, unwieldy, large, and heavy, or else very complicated and liable to get out of order. The only exception in part to this rule is the rocking microtome, made in Cambridge, England; but it cuts in an arc, so that the sections are segments of a hollow cylinder, and not parts of a perfect plane; besides, the rocking or vibrating arm admits of only a very limited movement, so that the instrument is suitable only for cutting sections of objects of very limited dimensions; nor is the position of the block adjustable. Moreover, in none of the automatic microtomes now in use is it possible to place the knife at right angles or any other desired angle to the direction in which the block to be cut is moved—a great desideratum in botanical or other work in which an inclined knife is necessary. In order to supply an instrument serviceable especially to teachers, as well as to all classes of students, botanists, pathologists, histologists, and zoologists, the designer has attempted to bring together all the desirable features of previously invented instruments, in as simple, convenient, and compact a form as possible, without sacrificing rapidity and efficiency of action."

FIG. 194.

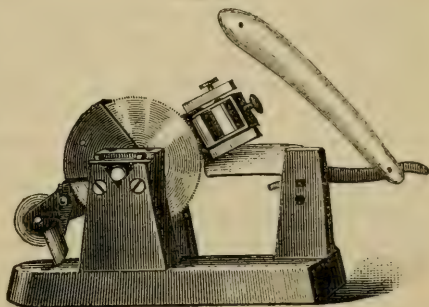
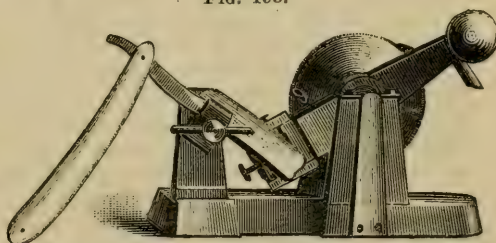


FIG. 195.



The working parts are an oscillating lever, which is provided with a clamp at one end into which paraffin-holders are adjusted, and at the other with a simple handle. This lever rests upon trunnions on either side, and these in turn rest in triangular notches at the top of the two pillars between which the lever oscillates. At the cutting end of the lever a spring pulls the lever down and effects the sectioning and also the adjustment for the next section. The lever is pushed over and adjusted for the successive sections by a hollow screw, through which passes the trunnion on the side away from the knife. This screw is fixed to a toothed wheel, 3 in. in diameter, which revolves close by the side of the oscillating lever. The toothed wheel and screw is actuated by a pawl fixed to the side of the lever near the handle. The number of teeth which this pawl can pass in a single vibration downward is controlled by a fixed stop screwed into the under side of the oscillating lever near the handle; the end of this stop striking on the top of the bed-plate thus brings the lever to rest at a constant point

in its downward excursion. An adjustable sector by the side of the toothed wheel throws the pawl out of gear after a given radius of the wheel has been turned through an arc embracing the desired number of teeth. This adjustment is also effected before the block, containing the object to be cut, reaches the edge of the knife. The adjustment for the next section is therefore effected while the surface of the block is not in contact with the under side of the knife, so that no flattening or scraping effect is produced on the surface of the block in its upward passage past the knife.

The movement of the vibrating lever being arrested at each down stroke at one point and the pawl which catches into the notches in the toothed wheel being released at any desired point by the action of the adjustable sector, it is possible to adjust the apparatus with great accuracy for cutting sections of any desired thickness. If a given radius of the wheel is moved through the arc embraced by a single tooth, sections are cut, having a thickness of only $1/10000$ of an inch, or 0.0025 mm.—a thickness which is only practically possible with paraffin imbedding and a very keen razor. If more teeth are taken by the pawl, any thickness of section is possible up to about $1/400$ of an inch, or 0.0625 mm. (The screw which adjusts the block for cutting has exactly fifty threads to the inch, and there are two hundred teeth on the periphery of the toothed wheel. The value of a single tooth is, therefore, $1/50 \times 1/200 = 1/10000$ in.).

A freezing attachment, which has lately been appended to the apparatus, shows that frozen sections can be made with as great rapidity and success as those cut from objects imbedded in the paraffin block, and very nearly, if not quite, as thin. Other auxiliary apparatus makes it possible to cut celloidin sections. This is effected by means of alcohol conducted by a tube from a reservoir to the knife, over which the fluid will run and drain into a tray below in such a way as not to come in contact with any other parts of the machine. This tray fits into a recess in the side of the bed-plate of the instrument just below the knife, and into this tray the celloidin sections may be allowed to drop as fast as cut.

The paraffin-holders are square and $7/8$ in. in diameter, so that a block of that size may very readily be sectioned. For the botanist, one of these holders is provided with a movable side and screw for clamping objects, so that rather tough stems may be firmly held between blocks of cork, while the more delicate vegetable tissues, or such as must be imbedded in fresh carrot, soaked in gum and hardened in alcohol, may also be firmly held for sectioning by the same device, provided the pieces of carrot are first trimmed into the right shape. The same style of holder is equally applicable for holding the corks—if properly trimmed—upon which tissues are imbedded in celloidin or in gum. This style of holder also enables one to imbed very long objects entire in paraffin—such as earthworms—and to cut them as a single piece, provided the surrounding paraffin is carefully trimmed so as to have two opposite sides parallel. An object 6 in. long and $3/4$ in. in diameter, imbedded in this way, may be cut into an absolutely continuous series of sections without losing any essential portions. This is accomplished by slipping the block through the quadrangular clamp for the distance of $1/2$ in. every time $1/2$ in. of the object has been cut off in the form of sections. $1/2$ in. is the length of block which can be cut at one time without readjusting the feed-screw which moves the block and vibrating lever over towards the knife, the whole being kept firmly in place against the face of the hollow screw by a strong spring which presses against the end of the trunnion on the outside of the iron pillar on that side of the instrument where the knife is fastened, so that all the sections are of exactly the same thickness, from

first to last. "Cutting up large objects in the manner above described is not possible with any other form of microtome yet constructed."

Almost any section-knife—wide or narrow-bladed—will fit into and be firmly held by the knife-clamp, which is, however, intended more especially to hold an ordinary razor.

For ribbon-cutting by the paraffin method, the block containing the object, after it is trimmed and soldered to the paraffin with which the holder is filled, by means of a heated wire, is covered with a thin coat of soft paraffin or "paraffin-gum," and of which "chewing-gum" is made. (Chewing-gum may be rendered available for this purpose, if it is melted at a temperature somewhat above boiling, when the sugar which it contains will separate as caramel, leaving the pure paraffin-gum, which may be drained off and used as directed, if the manipulator should find it difficult to get the paraffin-gum of commerce.) This enables one to cut ribbons of any desired length, since the softer paraffin at the edges of the successive sections sticks them together by their margins as fast as they are cut. The ribbons may be allowed to fall upon a slip of paper, which may be drawn out, as fast as the sections are cut, from under the bed-plate of the instrument, beneath which there is a space left for this purpose between the three toes or tripod upon which the whole apparatus rests. The edge of the knife also remains in the same plane, no matter at what angle the cutting edge is placed with reference to the direction in which the block to be cut is moved, just as in the best forms of the sledge microtome.

A section flattener can be attached in the form of a roller of hard rubber which turns loosely on a rod held parallel with the knife-edge. The roller is placed with its centre somewhat in advance of the knife-edge and the rod supporting it may be fastened to the back edge of the knife or be clamped in the position of the support which holds the tube conveying the alcohol to the knife when cutting celloidin sections.

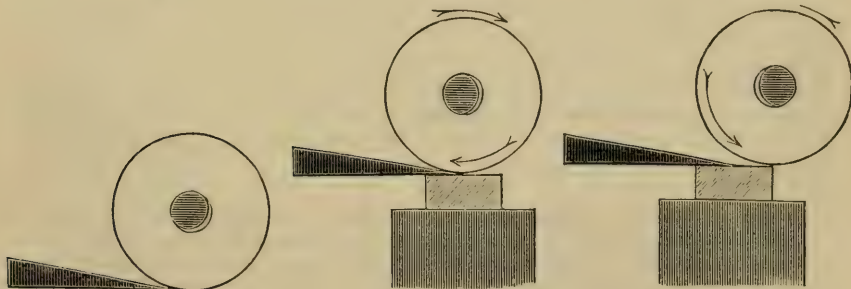
In cutting celloidin or collodion masses, it has been found that the greater the inclination of the knife the better the results, and it may be found expedient to devise a special form of clasp for cutting celloidin.

Mall's Section-smoother.*—Dr. P. F. Mall recommends a section-smoother constructed on the following principle. It consists of a rubber rod about $1\frac{1}{4}$ cm. in diameter, which rotates *loosely* on a solid axis. The

FIG. 196.

FIG. 197.

FIG. 198.



rod is so placed that it hangs a little below and in front of the edge of the knife (fig. 196). When the knife passes over the object, the rod is raised

* Arch. f. Anat. u. Physiol.—Anat. Abtheil., 1887, pp. 2-3 (3 figs.). Cf. Amer. Naturalist, xxi. (1887) p. 597 (3 figs.).

to an extent equal to the thickness of the section, and is thrown above and a little behind the edge of the knife (fig. 197), so that the section is prevented from rolling as it slides upon the knife. When the knife is pushed back preparatory to making the next section, the rod rolls over the preparation, and in consequence of the play of its axis, is kept free from the edge of the knife (fig. 198). The section does not stick to the rod as is the case in Jung's section-smoother.

Extemporized Section-smoother.*—Dr. W. C. Borden has invented a device for preventing sections imbedded in paraffin from curling. It consists of a bent glass tube, one end of which is passed through a hole in the table and into the other is fitted a camel's-hair brush. For most sections a round brush with long hairs is the most suitable, but for large sections a flat brush is to be preferred. The brush is to be so arranged that it lies lightly yet closely on the surface of the object to be cut. The thinnest and most delicate sections are not injured by this method and as the harder paraffins allow the thinnest sections to be cut, great success is obtainable by the combination of this flattener and hard paraffin.

Making Sections of Injected Lung.†—Mr. A. J. Doherty injects the lung *in situ* through the right ventricle with a stiff but freely flowing carmine-gelatin mass (Carter's formula), care being taken to throw the mass in slowly and with a uniform pressure, and not to over distend the vessels, either by injecting too rapidly or for too long a time. When properly filled the pulmonary arteries and veins are ligatured, the lungs are removed from the body, and are then distended with 90 per cent. spirit injected through the trachea, which is afterwards to be closed with a clip or bull-nose forceps. The lungs are then weighted with lead and placed in a quantity of 90 per cent. alcohol. In twenty-four hours they are taken out, the clip is removed from the trachea, and as much alcohol as possible is drained from the organs. After this, they are to be redistended with 90 per cent. alcohol and placed in a fresh quantity of spirits of that grade as before. This process is to be repeated on the fifth and tenth days, and at the end of a month the lungs will be found to be hardened without being in the slightest degree collapsed. Cut from one of the lungs, preferably at the root and transversely across a bronchus, a piece, say $1\frac{1}{2}$ in. square and $\frac{1}{4}$ in. thick; transfer it to a glass beaker half filled with methylated chloroform, place the beaker in a water-bath and heat to 100° F. Shake the vessel occasionally to facilitate the saturation of the tissue with the chloroform, and in half-an-hour, add very gradually (i. e. in small pieces, one after the other) about 50 per cent. of paraffin. Keep the lung in this mixture for one hour, and then transfer to a bath of pure paraffin, kept for two hours at 3° F. above its melting-point. The tissue will then be thoroughly infiltrated with the paraffin and beautiful sections can be made with a hand microtome and a sharp razor. The sections are passed through three consecutive changes of warm temperature, and finally are mounted in balsam and benzole.

GEOLTT, P.—*Le nouveau Microtome à levier.* (The new lever microtome—Hansen's.)

[Constructed generally on the Thoma plan, its characteristics being the use of a lever and the arrangement for cutting either dry or immersion. The object-holder is connected with the short arm of a lever, the arms of which are as 1 to 5. At each complete turn the micrometer-screw on the right, which acts on the long end of the lever, rises or falls 0.5 mm., so that the object-holder is moved 0.1 mm. Each of the fifty teeth of the head of the screw

* The Microscope, vii. (1887) pp. 97-8 (1 fig.).

† Ibid., pp. 101-2.

therefore represents a movement of the section through 0.002 mm. There is also an automatic arrangement. For wet cutting a fixed tray is added. A second form of the instrument has a movable tray, which can be lowered for dry or raised for wet cutting. In the latter case the object-holder is immersed. It is claimed that this plan of construction obviates the inconveniences of those microtomes which are reversible for immersion.]

Le Naturaliste, VIII. (1886) pp. 241-3 (8 figs.).

Journ. de Microgr., 1886, pp. 507-12 (6 figs.).

HAENSELL, P.—*Le Microtome et ses applications à l'anatomie de l'œil*. (The microtome and its applications to the anatomy of the eye.)

Bull. Clin. Nat. Ophthalm., IV. p. 106.

REDDING, T. B.—*Uses of Celloidin*.

The Microscope, VII. (1887) pp. 43-5.

ROSENBERG, P.—*Eine neues Microtom*. (A new microtome.)

Anat. Anzeig., 1886, pp. 211-3.

TYAS, W. H.—*Golding-Bird's small Ice Freezing Microtome*.

Trans. and Ann. Rep. Manchester Micr. Soc., 1886, p. 70.

(4) Staining and Injecting.

Fixing and Staining Nuclei.*—Mr. D. H. Campbell writes, that the following methods have been found to give excellent results in the study of nuclei. The observations were chiefly made with the mother-cells of the spermatozoids of various ferns, but the nuclei of vegetative cells also gave very instructive preparations.

In order to fix the nuclei, the prothallia were placed in aqueous solutions of chromic or picric acid or corrosive sublimate. The chromic acid solution should be a 1 per cent. solution; the others concentrated. In these solutions they should remain from one to two hours, though in the corrosive sublimate solution less time is required. The chromic and picric acid preparations must be washed in several waters before staining. It has been found a good plan to leave them overnight in abundant fresh water before the final washing. The sublimate preparations may be transferred to absolute alcohol, in which they should remain several hours.

The specimens are now ready for staining. The best results were obtained with hæmatoxylin and gold chloride. The secret of good hæmatoxylin staining is to use a very dilute solution; three or four drops of the prepared solution in a watchglassful of distilled water, and to allow the specimens to remain in this for at least twenty-four hours.

After taking the specimens from the hæmatoxylin solution, they must be passed successively through 50 per cent., 70 per cent., and absolute alcohol before mounting. Half an hour is usually sufficient for each of the alcohols. For immediate examination they may be mounted in glycerin, but for permanent preparations first in organum oil, and then transferred to Canada balsam (dissolved in chloroform.)

The gold chloride method is simpler, and is found to answer admirably for specimens fixed in picric or chromic acid; but with those fixed with the corrosive sublimate or alcohol, it has not answered so well. A few drops of 1 per cent. gold chloride in water are placed in a watchglass almost half-filled with distilled water, and the specimens are allowed to remain from one-half to one hour, the solution being kept in the dark. Strasburger recommends a trace of HCl, but with the picric and chromic acid preparations, although thoroughly washed, the author found this unnecessary. The specimens are then thoroughly washed, being at the same time exposed to the light and finally mounted in glycerin. With alcohol material, hæmatoxylin was found to give the best results.

The above notes embody (the author says) nothing specially new, but may be useful as a memorandum of work actually done.

* Bot. Gazette, xii. (1887) p. 40.

Staining Elastic Fibres with Victoria Blue.*—Dr. L. Lustgarten states that Victoria blue stains elastic fibres in the fresh condition if the preparations are hardened for 24 hours in chrom-osmic-acetic acid and then in spirit. 1–2 parts of an alcoholic solution of Victoria blue are mixed with four parts of water. Then alcohol and bergamot oil. The hue is blue-green. Nuclear staining is more successful with a watery solution, followed by alcohol, bergamot oil, and xylol balsam.

Staining Peziza Specimens.†—Mr. C. F. Fairman decolorizes the *Pezizæ* by soaking in a solution of corrosive sublimate (1 to 2000 aq. dist.); then washing from precipitated calomel by agitation in distilled water and macerating in 90 per cent. alcohol for twenty-four hours. For immediate examination, lower for a few seconds in a strong hæmatoxylin solution, wash in distilled water, or if preferred, use the dilute hæmatoxylin fluid. (See *supra*, p. 687.)

Staining relations of Leprosy and Tubercle Bacilli.‡—Dr. F. Wesener, who has recently investigated the receptivity of these bacilli for anilin dyes in order to ascertain if any crucial difference existed between these micro-organisms, finds that a diagnosis between the two must be made from several kinds of proof and not from one alone. With regard to the reaction to the simple anilin solutions (Weigert's method) he found that methyl-violet was more efficient than fuchsin for tubercle bacilli, but that such distinction did not hold good for leprosy bacilli; nor did he find a minimum time test of a satisfactory nature, although leprosy bacilli took up red dyes rather quicker. Nor did the more complicated solutions (Koch's, Ehrlich's, Ziehl's methods) afford any satisfactory test.

The author in view of the fact that a diagnosis must be made from differences of degree, advises the following stains if the Ehrlich method has demonstrated the presence of bacilli, and it is desirable to ascertain if the bacilli be those of leprosy or tubercle.

(1) Methyl-violet (in concentrated watery or dilute alcoholic solution) for twenty-four hours: decolorize in nitric acid. (2) Fuchsin as above. (3) Baumgarten's methods. (4) Four to six minutes in a watery solution of fuchsin: decolorize in alcohol. (5) The same with methyl-violet.

Staining Differences of Leprosy and Tubercle Bacilli.§—Prof. Baumgarten controverts the statement of Dr. Wesener with regard to the respective receptivity of leprosy and tubercle bacilli for anilin stains. By using a dilute solution of fuchsin and immersing the sections for 12–15 minutes, and then decolorizing in nitric acid (1–10) with after-staining in methylen-blue for 2–3 minutes and dehydration in absolute alcohol 3–4 minutes, the leprosy bacilli show red, the tubercle bacilli are unstained. Or the sections may be stained in the Ehrlich fuchsin for 2–3 minutes with subsequent procedure as above. Cover-glass preparations give analogous results, for leprosy bacilli will stain in 6–7 minutes in a cold dilute alcoholic solution of fuchsin, but tubercle bacilli will not. Yet Prof. Baumgarten would not rely alone on colour reaction—the point at issue, by the way—but would also take into consideration the position and arrangement of the microbes and verify the results by inoculation experiments.

Decoloration of Bacteria stained with Anilin dyes.||—Dr. A. Spina, starting from the observation that cotton fibre treated with tannin as a mor-

* *Medicin. Jahrb. K. Gesell. der Aerzte zu Wien*, 1886, pp. 285–91 (1 pl.).

† *Bot. Gazette*, xii. (1887) p. 85.

‡ *Centralbl. f. Bacteriol. u. Parasitenk.*, i (1887) pp. 450–6.

§ *Ibid.*, pp. 573–6.

|| *Allg. Wien. Med. Ztg.*, 1887, Nos. 15 and 16.

dant gives up anilin stains to acids very slowly, subjected some fission fungi to a corresponding treatment. Dry preparations of rotting meat infusion treated with a strong tannin solution, and then stained for twenty-four hours with anilin or methyl violet, were found to be thoroughly stained after acid, while the preparations not treated with tannin were either only faintly stained or not at all. The difference became more apparent if a saturated solution of tannin were used, and this peculiarity was found to affect all kinds of Bacteria alike. A similar effect, but less marked, was obtained with various albuminates and fats. By preparing a decomposing fluid containing tannin, the author found the same resistance to acids in living Bacteria.

Demonstration of Phloroglucin.*—Herr O. Lindt has discovered that vanillin in very dilute solution (1:1000) gives a colour reaction with phloroglucin and orein, but not with resorcin. Both these bodies are, however, sharply distinguished from each other by the different colour given to these solutions. The phloroglucin is a bright red, assuming a violet-red tone later on. The orein solution is a bright blue with a trace of red. The reaction is so sensitive that 0.000001 gram. of the dry substance can be easily recognized on the addition of a drop of the vanillin solution made according to the following formula:—Dissolve vanillin 0.005 gram. in spirit 0.5 gram., to this add water 0.5 gram., strong hydrochloric acid 3.0 gram. The reaction takes place so quickly that the disturbing influence of secondary appearances does not interfere with the histo-chemical investigation.

It is, however, necessary that the microscopical sections should be previously dried on the slide, because water impedes the reaction and lessens its intensity. It is further recommended that a control examination should be simultaneously carried on. By means of this solution the author has been able to determine the presence of phloroglucin in tissues which have been hitherto supposed to be devoid of it. On the other hand, phloroglucin was found to exist in considerable quantity in the tissues of certain leaves which later on became crimson, although the leaves of most plants which remain green in autumn contain little or none.

Dr. Lindt suspects that the red colour of certain leaves and plant stems is not less dependent on the presence of phloroglucin than on the existence of a certain quantity of tannin, for it is quite possible that the relations which exist between the latter and the red colouring matter may depend on a similar reaction of certain transformation-products due to the action of tannic acid on phloroglucin—a reaction comparable to the effect of vanillin on phloroglucin.

It may be mentioned that the presence of a mineral acid does not seem to be indispensable to the appearance of the reaction, for if vanillin, phloroglucin, and oxalic acid be dissolved in water and the solution evaporated to dryness, the residue is bright red.

Staining Preparations for Photography.†—Dr. P. Francotte gives the results of experiments in photographing preparations stained with various colours.

For picro-carmin preparations two baths are necessary—(1) The plate is steeped for two minutes in distilled water 200 cc.; ammonia 2 cc. (2) Then for two minutes in distilled water 200 cc.; ammonia 2 cc.; alcohol 10 cc.; solution of cyanin 1:500 in absolute alcohol 5 cc.

* Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 495-9.

† Bull. Soc. Belge Micr., xiii. (1887) pp. 151-8.

The plates are placed on blotting-paper and dried rapidly. They only keep for a few days.

For preparations stained with vesuvium, Bismarck brown, methyl-green, or picro-carmin with yellow and red stain, the formula which gives the best results is that of Mulman and Scolik:—1 gr. of quinoline red is dissolved in 500 cc. alcohol, and 50 cc. of an alcoholic solution of cyanin 1:500 is added. The plate is steeped for a minute in water 100 cc.; ammonia 1/2 cc. It is then transferred to a bath composed of the quinoline red solution 1 cc.; water 100 cc.; ammonia 1/2 cc., for one minute. The superfluous water having been removed with blotting-paper, the plate is dried in a stove at about 30°.

For preparations stained with any colour the following formula succeeds well:—Bath for two minutes in a watery solution of erythrosin 1:1000, 25 cc.; ammonia 4 cc.; water 175 cc. If the preparations are stained red, 1 cc. of an alcoholic solution of cyanin 1:500 is added.

Another formula is—Solution of erythrosin 1:1000, 25 cc.; solution of silver nitrate 1:1000, 25 cc.; water 50–100 cc.; and if the preparations are deeply stained with red, the author adds 5–10 cc. of an alcoholic solution of cyanin 1:500.

Dr. Francotte remarks that it is absolutely indispensable to use orthochromatic plates when dealing with coloured preparations, and if the stain be blue or violet, a yellow glass must be interposed between the light and the preparation.

For developing, the author prefers pyrogallie acid and sulphite of soda. Four baths are required:—(1) 10 gr. pyrogallie acid dissolved in 100 cc. of alcohol at 90°. (2) 100 gr. of pure sulphite of soda dissolved in 200 cc. distilled water. (3) 100 gr. of pure carbonate of soda dissolved in 200 cc. distilled water. (4) An aqueous 10 per cent. solution of bromide of potash.

In order to develop, 5 cc. of No. 1, 10 cc. of No. 2, and 5 cc. of No. 3 are poured into a vessel containing 100 cc. of water, and if the time of exposure be in excess, a few drops of No. 4 are added.

The time of development is about five minutes.

Fixing is performed in the usual way. If the plates are still coloured after the operation (and this often happens) they are immersed in a bath of spirit at 90°, to which a few drops of ammonia are added.

BIDERT.—Ein Verfahren, den Nachweis vereinzelter Tuberkelbacillen zu sichern, nebst Bemerkungen über die Färbbarkeit der Bacillen und Aetiologie der Tuberculose. (A process of authenticating the presence of single tubercle bacilli, with remarks on the staining capacity of the bacilli and the ætiology of tuberculosis.)

Berl. Klin. Wochenschr., 1886, Nos. 42, 43.

Cf. *Centrabl. f. Bacteriol.*, I. (1887) p. 55.

DEKHUYZEN, M. C.—Ueber die Tinction. (On staining.)

Centrabl. f. d. Med. Wiss., 1886, Nos. 51–2.

DOHERTY, A. J.—The Staining of Animal and Vegetable Tissues.

["The object of the present paper, which is addressed to professed biologists as well as to *dilettanti*, is twofold; firstly, to record the results of my own extensive researches into the properties of staining reagents; and secondly, to place before the microtometist in a condensed form an account of various processes adopted by other workers with the Microscope."]

Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 1–19.

GRIGERJEW, A.—[On Ehrlich's Staining of Micro-organisms.]

Russkaja Med., 1886, No. 42.

HERXHEIMER, C.—Ein neues Färbungsverfahren für die elastischen Fasern der Haut. (A new staining process for the elastic fibres of the skin.)

Fortschr. d. Med., IV. (1886) p. 787.

KAMENSKI, D. A.—Eine neue Methode die Koch'schen Bacillen im Sputum zu färben. (A new method of staining Koch's bacilli in sputum.)

Wratsch, 1887, pp. 276–7 (in Russian).

- LATHAM, V. A.—The Microscope and how to use it. **XI. Injecting, &c. (contd.)**
Journ. of Microscopy, VI. (1887) pp. 169-79.
- LUSTGARTEN, S.—Victoriablau, ein neues Tincttionsmittel für elastische Fasern und für Kerne. (Victoria blue, a new staining medium for elastic fibres and nuclei.)
Wiener Med. Jahrb., 1886, p. 285.
- [MANTON, W. P., AND OTHERS.]—Stains.
 ["How often, for instance, we read of a new objective that promises wonders. Such and kindred productions, of great value withal, are examined and discussed, till the next new objective or what-not displaces it. All this is as it should be. But do we show the same enthusiasm and interest over a new stain that allows us, perhaps, to study some object more satisfactorily with a 1/6 than could formerly have been done with a 1/8? We think not. All this is wrong. Is the new apochromatic glass—granting, even, all that is claimed for it—of greater importance to us than the results of the studies in the anilin dyes that individualized the *B. tuberculosis*? There are many who hold that we have about reached the limit of perfection in lenses. Be this as it may, the goal certainly does not seem to be so very far distant. But the province of stains has not as yet been invaded to any very great extent. And especially is this true as regards differential staining."]
The Microscope, VII. (1887) p. 110.
- REYNOLDS, R. W.—Injecting and cutting sections of the Cat.
The Microscope, VII. (1887) pp. 156-9.
- UNNA, P. G.—Ueber Erzeugung von Vesuvien im Gewebe und über Metaphenylendiamin als Kernfärbemittel. (On the formation of vesuvin in the tissues and on metaphenylendiamin for nuclear staining.)
Monatschr. f. prakt. Dermatol., 1887, p. 62.
- V., R. E.—Permanganate of Potash as a Staining Medium for Micro Objects.
 [For examining tissues of plants. "It defines edges of cells, markings on cell-walls, &c., more strongly than other dyes."]
Engl. Mech., XLV. (1887) p. 346.
- WEIGERT, C.—Ueber eine neue Methode zur Färbung von Fibrin und von Microorganismen. (On a new method of staining fibrin and micro-organisms.)
Fortschr. d. Med., 1887, pp. 228-32.
- WELLINGTON, C.—Staining and Mounting Plant Sections.
The Microscope, VII. (1887) pp. 133-4.

(5) Mounting, including Slides, Preservative Fluids, &c.

Flask for dehydrating specimens to be mounted in balsam or paraffin.*—Dr. P. Francotte's dehydrator, the idea of which is taken from Schulze's apparatus,† consists of a broad-necked flask to hold about half a litre. This contains alcohol and sulphate of copper. Into this flask is passed a dialysing tube, 5-6 cm. in diameter. It is closed above by a plate of glass, and below by a piece of parchment paper. The flask is plugged with a muslin bag filled with quicklime. The flask contains a float for marking the strength of the spirit from 94°-100°. A similar float is placed in the dialysing tube, and when the spirit in this tube is of 100°, it is emptied into the flask. The specimen is placed in the tube along with alcohol at 94°, and care has to be taken that the level of the liquid in the tube is the same as that in the flask. The apparatus works more quickly in a warm place.

Permanent Preparations on firm media.‡—Dr. J. Soyka when employing firm opaque nutritive material, as bread, potato, rice, uses round glass vessels about 6 cm. in diameter and 3 cm. high. The edge is bent outwards at the top for about 1 cm. and well ground, so that a plate of glass about 8 cm. in diameter can be cemented on. These vessels are then carefully stuffed to the height of 1 cm. with the medium, and the surface of the latter carefully levelled. After having been sterilized and inoculated with the cultivation the sterilized cover is cemented on. Pure cultivations, as bread and potato, will keep for at least two years, and thus are always ready

* Bull. Soc. Belge Micr., xiii. (1887) pp. 146-7.

† See this Journal, 1886, p. 537.

‡ Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 542-4.

for demonstration purposes. In an analogous manner may be preserved macro- and microscopical preparations. For this purpose small glass vessels like watch-glasses with flat bottoms are used. The floor is about 5 cm. in diameter, and the walls may ascend vertically or obliquely. Upon these a thin glass cover is placed, after the nutrient medium, with the bacteria to be cultivated, has been poured in. The organisms may or may not be developed in an incubator. Low powers are always available for inspecting the results of this method through the cover-glass, and if the gelatin or agar layer be very thin higher powers can be used. Before closing permanently it is advisable to wash the surface of the gelatin, &c., with a sublimate solution 1:1000. Drops of moisture which may condense on the cover and so obscure the colonies may be avoided by placing on the top a piece of warm glass or metal.

Use of Styrax in Histology.*—Dr. P. Francotte recommends styrax instead of balsam when the latter renders the object too transparent, e. g. for bacteria and in the study of karyokinesis styrax gives a greater resolution than balsam, while its slightly yellow tint is eminently favourable for photographic purposes. The author has obtained with ordinary plates excellent figures of the cells in the branchiæ of larvæ of salamander from specimens mounted in styrax, while similar preparations mounted in balsam required isochromatic plates or the use of chrysoidin previous to the eosin.

No excess of balsam necessary.†—Mr. J. E. Whitney emphasizes the fact that there should not be any surplus balsam to remove from around the cover. Experience soon learns to graduate the amount so that it will fill the required space. The balsam slide and cover should be exactly centered, and if the balsam happen to be too thick a very slight amount of heat will make it flow to the edge. It is a good rule to mix a little less balsam than seems necessary, as a little pressure will squeeze the balsam right out to the edge. When a cell is used it is impossible, however, to avoid some excess of balsam, as it needs to exude slightly around the cover to drive out the air from the cell; but even in this case, if carefully graduated to the cell, the excess need not be noticeable, and it can be covered with a ring of cement without being cleaned away at all.

Mounting Opaque Objects.‡—Mr. C. M. Vorce deprecates the use of pasteboard slides for mounting opaque objects; for even when of heavy tarboard they bend so readily as to crack or loosen the covers very easily, and, unless well saturated with some resinous varnish, are liable to mould or to take up moisture and deposit it under the cover. Even covered with paper they do not stand reasonable wear. Wooden slips are vastly better, and can be cheaply made by boring a hole centrally edgewise through a piece of wood 1 in. thick and 3 in. long of any width, and slitting it upon a saw table. But for this class of objects, for which low powers will ordinarily be sufficient, glass is the best material, and admits of examining both sides of the object. For objects that must be viewed uncovered and on both sides, no other mount will equal two of Pierce's capped cells mounted back to back with the object between and fixed in a wooden slip, either temporarily or permanently, or on a metal plate.

Mounting Opaque Objects on a Micrometer Background.§—Mr. R. Parkes writes:—"Most people on looking at an object under the Microscope

* Bull. Soc. Belg. Micr., xiii. (1887) pp. 144-6.

† The Microscope, vii. (1887) pp. 98-9.

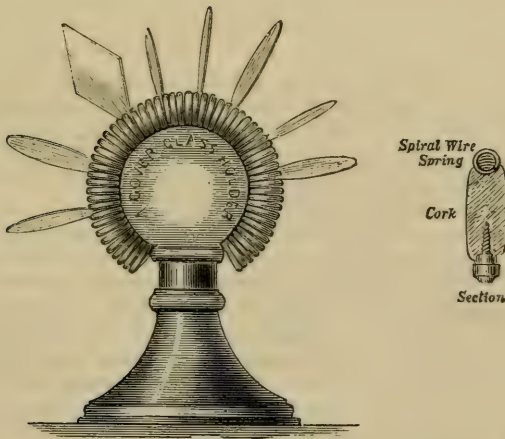
‡ Amer. Mon. Micr. Journ., viii. (1887) pp. 92-3.

§ Trans. and Ann. Rep. Manchester Micr. Soc., 1886, pp. 58-9.

for the first time wish to know the natural size of the object exhibited, and for all opaque objects which could be mounted on a white, black, or coloured background, this information can be best attained by printing on the ground a scale ruled, say, one hundred lines to the inch, and upon which the object can be mounted, when its size will be at once apparent. I have engraved and brought down for presentation to the Society a ruled plate and other requisites, which will enable those members who care to do so, to produce any number of scales required. The plate before being used should be cleaned with turpentine, and the colouring matter rubbed in dry, lampblack, or any other powder colour will do, the excess colour being wiped off by passing a piece of tightly wrapped wash-leather across the plate. A piece of smooth wood or glass should then be taken, and soap or bees'-wax drawn across the face, and the paper about to be printed on should be laid upon it, the soap making it adhere to the face and keeping it straight. The soap or wax should then be passed over the paper, taking care to have a smooth and even film. The paper being thus prepared should be placed on the plate and the back rubbed lightly with the steel burnisher provided, and, on removing it, a clear impression of the scale will be found imprinted on the surface. If ordinary note-paper be used, many objects can be well illuminated by sending light through from the mirror of the Microscope. I have also engraved for the Society a metal micrometer ruled 100, 250, 500, and 1000 lines to the inch, which the members will find useful for measuring opaque objects. It has the advantage of not being so liable to break as the glass micrometers, and can be readily used with all powers up to $1/6$ in. objective."

Cover-glass Holder.*—Dr. F. L. James describes the device (fig. 199) for holding cover-glasses after they are cleaned and ready for application to the slip. It consists of a coil of brass spiral spring wire bent round a

FIG. 199.



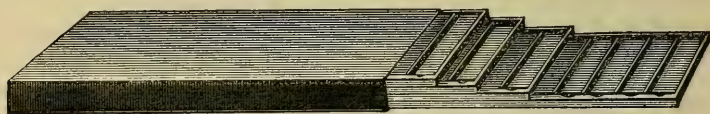
cork, which has been grooved to receive it. The method of using is illustrated by the cover-glasses in position on it.

* Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, p. 145 (2 figs.).

James's Improved Slide Cabinet.*—Dr. F. L. James fastens, by marine glue, to the under side of each tray, pieces of vulcanized indiarubber, $\frac{1}{2}$ in. in diameter, and $\frac{1}{8}$ in. in thickness. These pieces are so arranged that one of them comes on each end of the slide beneath it in such manner that the slide is prevented from rising up against the bottom of the superincumbent tray. The slips in the upper tray are held in place by similar bits of rubber fastened to the cover of the box.

Griffith's Pocket Slide Cabinet.†—Mr. E. H. Griffith's cabinet (fig. 200) is intended especially for pocket use. It is similar to another already in the

FIG. 200.



market, but in the place of rack-work in that, trays are used in this. A feature in its favour, that will be appreciated by those who carry slides in pockets, is its security from opening.

BAKER, S. W.—Wax Cells.

[Made by building up layers of artists' wax on the slide, which is placed on the turning-table, and a cut made through the first layer of wax the size of the cover-glass intended to be used, and the centre taken out; a cut is then made with a needle a little inside of the first cut, extending down to the glass; the centre is then removed and another cut made through the wax a little outside of the first cut, leaving a wall of wax to form the cell. This is finished by smoothing with a piece of ivory, shaped like a chisel, thoroughly varnishing, inside and out, with Brown's cement. By using dark-coloured wax for the first sheet next the slide, and leaving it as a bottom to the cell, a background can be made to suit any object.]

Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, p. 196.

BROKENSHIRE, F. R.—Mounting without Pressure.

Scientif. Enquirer, II. (1887) pp. 135-8.

CALDWELL, C. T.—New Cement.

[“It is simply the article sold at the paint and oil stores under the name of ‘hard oil finish.’ . . . It runs freely, makes smooth rings, dries readily and quickly, and is extremely adhesive. It is cleanly.”]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 98-9.

ELIEL, L.—Gums and Pastes for Labels.

Engl. Mech., XLIV. (1887) pp. 535-6.

HOPKINS, G. M.—A quick method of mounting dry objects.

[Recommends metal rings with a narrow internal flange at the top for the cover-glass, and a wider external flange at the bottom for attachment to the slide.]

Engl. Mech., XLV. (1887) pp. 310-11 (2 figs.), from *Scientific American*.

JAMES, F. L.—Device for centering and holding the slide upon the turntable.

[“It consists of the ordinary triangular jaws pivoted exactly opposite to each other, and the acute end of one of the slips resting against a good strong spring. The slip is shoved into place from the open end of the jaws, opposite to the end held by the spring. A slide placed between these jaws is held as firmly as in a vice, and the cell can be turned down or manipulated exactly as though it were in a lathe.”]

Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, p. 146.

KELLYCOTT, D. S.—Kaiser's Glycerin Jelly for Plant Sections.

[“Stained leaf sections are best shown in Kaiser's glycerin jelly to which a large per cent. of gelatin has been added.”]

The Microscope, VII. (1887) p. 152.

* *Proc. Amer. Soc. Micr.* 9th Ann. Meeting, 1886, p. 146.

† *Ibid.*, p. 152.

Laboratory Notes.

[Preserving a specimen temporarily by applying a drop of glycerin at the side of the cover-glass in such a manner as to effect a union between the water and the glycerin; value of dried specimens of algae, &c.]

Amer. Natural., XXI. (1887) pp. 477-9.

TRZEBINSKI, ST.—Einiges über die Einwirkung der Härtungsmethoden auf die Beschaffenheit der Ganglienzellen im Rückenmark der Kaninchen und Hunde. (On the influence of hardening methods on the condition of the ganglion-cells in the spinal cord of rabbits and dogs.) *Virchow's Arch. f. Path. Anat.*, CVII. (1887) p. 1.

WILLIAMS, C. F. W. T.—Mounting in Castor Oil.

[Cell to be made with Ward's brown cement and filled with best castor oil. "For plant crystals, such as raphides and the like, there is no preservative so good in my opinion as this oil."

Sci.-Gossip, 1887, p. 138.

(6) Miscellaneous.

New Micro-chemical Reaction for Tannin.*—Experiments were made by Herr J. W. Moll, for the purpose of discovering a good reagent for tannin in the cells of plants, which should give a precipitate sharply separated from the surrounding fluid, and at the same time should show clearly the distinction between the tannins which colour iron green, and those which colour it blue. He obtained the desired results with lithium chlorate, copper acetate, copper nitrate, lead nitrate, and uranium acetate, the iron-salt used being the acetate. Of these copper acetate answered the best.

The living parts of plants to be examined were cut into small pieces and left in a saturated solution (7 per cent.) of copper acetate for from eight to ten days; longer immersion produces no injurious results. The sections were then placed on the slide in a drop of 0.5 per cent. iron acetate solution, but allowed to remain in it only for a few minutes, as longer action colours the cell-walls brown. After washing with water, and then with alcohol to remove the air and chlorophyll, they were examined in glycerin, or glycerin jelly, in which they remain unaltered for a lengthened period, even as much as two years. Or the sections may be removed directly from the copper acetate into alcohol, and examined afterwards with the assistance of iron acetate. The distinction between the tannins which give green and blue colours with iron were very clearly brought out. Thus in branches of *Fagus* the tannin-cells of the bark were coloured green, those of the pith blue.

Micro-chemical Reactions based on the formation of Crystals.†—MM. Klement and Renard have published an important paper on micro-chemical reactions. The methods available for the qualitative analysis of minute quantities of a substance are spectroscopic analysis, blow-pipe analysis, and micro-chemical reactions. The last method depends on the form and appearance of the crystals deposited by the action of reagents. Availing themselves of the researches of Boricky, Behrens, Streng, Lehmann, Haushofer, and others, combined with the results of their own extensive researches, the authors have produced the most complete account of the subject which has yet appeared. They describe the methods of research and the reactions, simple and characteristic, by which compounds of more than fifty elementary bodies may be identified in minute crystals recognizable under the Microscope. They also give a brief description of the processes of isolation and identification applicable to such compounds as the mineral constituents of rocks. The value of the treatise is much enhanced by the accompanying plates, eight in number, comprising nearly 100 figures of the forms of crystals obtained by the various reactions described in the text.

* Maandbl. voor Natuurwet., 1884. See Bot. Centralbl. xxiv. (1885) p. 250.

† Cf. Bull. Soc. Belg. Micr., xii. (1886) pp. 11 and 55-6.

- ERMENGHEM, E. VAN.—*Manuel technique de Microbiologie d'après l'ouvrage de Hueppe Bacterien-Forschung.* (Manual of Microbiological Technique, after Hueppe's 'Bacterien-Forschung.') 500 pp., 76 figs. and 2 pls., 8vo, Paris, 1887.
- JAMES, F. L.—*Elementary Microscopical Technology.* A Manual for Students of Microscopy. In three parts. Part I. The technical history of a slide from the crude materials to the finished mount. 107 pp. and 15 figs., 8vo, St. Louis, Mo., 1887.
- ” ” *Clinical Microscopical Technology.* IV. The examination of Urine.
- V. Urinary Examinations: Inorganic Sediments. *St. Louis Med. and Surg. Journ.*, LII. (1887) pp. 289-91, 349-51.
- [MANTON, W. P., AND OTHERS.]—*Elementary Department.* Third and Fourth Lesson. "Cleanliness is akin to godliness." *The Microscope*, VII. (1887) pp. 146-7, 172-6.
- SATTERTHWAITE, T. E.—*Practical Bacteriology.* 85 pp., 16mo, Detroit, 1887.
- STÖHR, P.—*Lehrbuch der Histologie und der mikroskopischen Anatomie des Menschen mit Einschluss der mikroskopischen Technik.* (Manual of histology and human microscopical anatomy, including microscopical technique.) 199 figs., 8vo, Jena, 1887.
- TAYLOR, T.—*Reply to Professor Weber.* *Proc. Amer. Soc. Micr.* 9th Ann. Meeting, 1886, pp. 116-9 (1 pl.).
- WEBER, H. A.—*Microscopic examination of Butter and its Adulterations.* [Concludes that "the microscopic methods as laid down by Dr. Taylor are of no practical value in the examination of butter for adulterations."] *Proc. Amer. Soc. Micr.* 9th Ann. Meeting, 1886, pp. 103-15 (1 pl.).
- ZUNE, A.—*Etude microscopique et microchimique des Farines et des Féculs ou application du Microscope à la recherche de leurs falsifications et de leurs altérations.* (Microscopical and microchemical study of flour and starch, or application of the Microscope to the investigation of their falsifications and adulterations.) *Mon. du Praticien*, II. (1886) pp. 166, 183, 211, and 263.
-

PROCEEDINGS OF THE SOCIETY.

MEETING OF 8TH JUNE, 1887, AT KING'S COLLEGE, STRAND, W.C.,
THE PRESIDENT (THE REV. DR. DALLINGER, F.R.S.) IN THE CHAIR.

The Minutes of the meeting of 11th May last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

From

- | | |
|---|----------------------|
| Crookshank, E. M., M.B., Manual of Bacteriology, 2nd ed., xxiv. and 439 pp., 29 pls. and 137 figs. (8vo, London, 1887) .. | The Author. |
| Lithograph of Microscopic Objects under the same magnifying power (the original was given to the late Dr. Carpenter, C.B., by Dr. Oliver Wendell Holmes, by whom it was drawn) .. | Dr. P. H. Carpenter. |
| Photomicrographs of Diatoms ($\times 840$). No. 71, <i>Nitzschia</i> (?) with membrane attached; No. 66, <i>Cocconeis</i> (lower plate), with membrane attached; No. 175, <i>Cocconeis</i> (another negative) with membrane attached; No. 73, cast of <i>Heliopelta</i> (?); No. 74 do. | Col. R. O'Hara. |

Col. R. O'Hara's note on the "Means of Movement possessed by the Diatomaceæ" was read as follows:—

"In my former communication on this subject I stated that I believed that in many cases this means of movement consisted in an undulating membrane, and I gave a drawing of the same as attached to *Navicula*. I send now an enlarged photograph of the membrane as attached to *Pinnularia* or *Nitzschia*, and also an enlarged photograph of the lower plate of a *Cocconeis* with the membrane attached, and showing the undulations exactly, as I thought, I had seen in action as stated in my former note.

I further send two photographs of what I take to be casts of *Actinocyclus* or *Heliopelta*, many of which were in the gathering; but as I have not, so far, found them attached, they may be anything else. They will, however, explain most distinctly what I mean by the expressions, cast, and undulating membrane."

Mr. J. Deby said that he was stated at the last meeting (*ante*, p. 533) to have given slides of *Pediculus* to the Society. This was, however, an error, and the slides were much more interesting, as being the original slides which led to the discovery of the development of *Meloë*, a parasite of bees. The older naturalists, who did not know what these little lice-looking creatures were, had named them very erroneously *Pediculus Melittæ*. This "*Pediculus*" was the larva of a coleopterous insect, and undergoes a metamorphosis which the genuine *Pediculi* are exempt from.

Mr. Crisp read a letter from Mr. L. Dreyfus, late a member of the Council, who was now residing at Wiesbaden, accompanying a notice as to the Scientific Exhibition in connection with the 60th Congress of German Naturalists and Physicians, to be held in Wiesbaden from the 15th to the 24th September next, the attendance usually numbering about 3000. It is intended to be strictly scientific, not mercantile, and as its purpose will be to show at a glance the latest and most perfected instruments and apparatus which have been placed at the disposal of science and medicine in the last few years, anything that cannot lay claim to be ranked in this category will be rigorously excluded. No charge will be made for space, insertion in catalogue, or anything else, and the instruments will be

covered against risk by fire at the expense of the committee. Among the 17 groups is one for "Instruments of precision, with subdivision for Microscopy," as well as one for "Instruments and apparatus aiding instruction in Natural History." Applications should be addressed to the "Ausstellungs-Committee der 60. Versammlung Deutscher Naturforscher und Aerzte," or to Mr. Dreyfus, 44, Frankfurterstrasse, Wiesbaden, where also further particulars can be obtained.

Dr. E. M. Crookshank exhibited a series of cultivations of micro-organisms, and called attention to the somewhat unusual circumstance of being able to show such a typical series all growing at the same time. Many of the kinds exhibited were by this time tolerably familiar to those who were interested in such subjects; but there were one or two of more particular interest about which he would say a few words. He had sometimes drawn attention to the fact that the chromogenic bacteria generally develop their colour only on the surface of the gelatin, but a specimen now shown formed an exception to this rule. It was interesting as being the first *Spirillum* which had been cultivated artificially, and being a chromogenic *Spirillum* had developed its colour in the depths of the gelatin contrary to the general rule. Another specimen was that of *Bacillus figurans*, seen growing upon the surface of the gelatin. When first described, some persons were sceptical as to the fact of a *Bacillus* developing such a symmetrical pattern; but it could now be cultivated quite easily, and he should be happy to supply any one interested in the matter with material from which it could be grown as symmetrically as in the example before them. He also showed a micro-organism which had been said to cause the swine fever—or rather, the swine erysipelas—in Germany. It was to be noted that in Germany there had been many cases of swine disease, and that a different organism had been found associated with it there from the one found here and recognised as the cause of Dr. Klein's swine fever. So far as he (Dr. Crookshank) had been able to make out, they were not identical, the German form being an extremely minute *Bacillus* forming only a cloudy appearance, and seeming to be similar to mouse septicæmia. He thought there was good ground for regarding the two diseases as distinct from each other, the German form being swine erysipelas as distinct from swine fever. He also exhibited an example of a *Bacillus* obtained from putrid fish, which caused the remarkable phosphorescence frequently noticed when fish was decaying.

The President complimented Dr. Crookshank on the remarkable series which he had exhibited, illustrative of a department which he had made so much his own.

Mr. Freeman exhibited a number of series-sections of the anatomy of spiders, worms, &c., which had been made by Mr. Underhill, of Oxford. They were rather remarkable specimens of section-cutting and mounting, in some instances from 30 to 60 consecutive sections having been obtained from the same spider. Some drawings taken from the slides were also exhibited.

The President, referring to a drawing of a longitudinal section through a spider, showing all the organs *in situ*, asked if the section from which this was taken was included in the series exhibited?

Mr. Freeman said that this drawing was not taken from any one section, but was a composite drawing intended to show the internal structure as revealed by the examination of a great number of sections.

Mr. Eve said that though bringing microscopic sections to the Society seemed like "carrying coals to Newcastle," he had ventured to bring some specimens of *Actinomyces* from the jaw of an ox, with a specimen from the Royal College of Surgeons' Museum of the jaw showing what the disease was. The effect upon the animal was to produce tumours in the jaw, and the disease occasionally spread so as to affect the kidneys, intestines, and other parts of the body. The organism consisted of a number of spheres, each having a structureless centre, round which large numbers of *Actinomyces* were arranged very much in the same way as pins might be stuck on a round pin-cushion. The inflammatory new formation was very much like what occurred in the growth of tubercle or syphilis. The disease could be communicated by inoculation to other cattle, and also in the same way from man to the rabbit. The sections were prepared by staining first with a magenta solution, which selected the micro-organisms, and afterwards with a watery solution of methyl-blue, which stained the tissues.

Dr. Crookshank said, with regard to the disease referred to as existing in man, his own view was that there was very little ground for supposing it to be the same as that of the ox. The bovine disease was very clearly marked, and could hardly be mistaken; but he might say that although clinically the two forms of disease might appear very much the same, the fungus which had been found in man differed very materially in its microscopic features from that obtained from diseased cattle. The new method of staining these objects with magenta picric acid would be found very effective; he had tried a great number with success by using orcin and then gentian violet.

Mr. Crisp read a circular which had been sent descriptive of a new glycerin-immersion objective, in which he said were crowded as many optical and other errors as could well be compressed into the space. (*Supra*, p. 645.)

Prof. Rupert Jones and Mr. C. D. Sherborn's paper, "Remarks on the Foraminifera, with especial reference to their Variability of Form illustrated by the Cristellarians, Part II.," was read. (*Supra*, p. 545.)

Mr. G. Massee gave a résumé of his paper "On the Genus *Lycoperdon*," illustrating the subject by drawings upon the blackboard. (*Post*.)

Prof. Bell said that the Fellows of the Society would probably remember that in the course of last winter he took the opportunity of describing what he had been able to observe in the case of some diseased grouse which had been sent to him for examination. Within the last few weeks the disease, whatever it might be, had been killing grouse in considerable numbers on the moors in the south-west of Scotland, though it did not appear to prevail to any great extent elsewhere. In the month of May last he received some of these diseased grouse in fairly good condition, and he examined them very carefully to see if he could discover any cause of death, because on the former occasion the tape-worms were all that could be found, and these did not seem sufficient to cause death by themselves. The first grouse which he examined this year were fairly well nourished, and again the tape-worms were found; he looked carefully, as before, for the small round-worm (*Strongylus*) mentioned by Dr. Cobbold, and again he found it to be absent. In this case, however, he found the intestines were inflamed and gorged with blood; not finding anything further, he wrote to say that they should be examined by a pathologist rather than by a helminthologist. More recently he had received from Sir

William Wallace a grouse which was in a most emaciated condition, there being hardly anything of it but skin and bone. He examined this, and again found tape-worms, and also Dr. Cobbold's *Strongylus*. This being so, they had now three sets of grouse which had died from disease; but the only actual fact before them was that the grouse were dead. In the case of the first, though there were tape-worms, there was no evidence that they were the cause of death. In the second case, the birds had died from inflammation of the intestines, the cause of which was not quite clear; and, in the third case, they died of *Strongylus*. It would therefore appear that what was called "grouse disease" must be either more than one disease, or it must be a disease which would kill the victim in different stages. He was himself disposed to think that there was more than one cause of disease; but up to that time there was no diagnostic sign internally to show conclusively what those causes were. The gamekeepers were a class who were properly supposed to know a great deal about natural history, and they said there were certain outward signs which were sure indications that birds were affected by the disease—they were, however, not comparative anatomists, and perhaps their science generally was to be received with some reserve. Taking as an instance the case of the ptarmigan, a species closely allied to the grouse, it was found that in winter it had a very large number of feathers upon its feet; but as the spring advanced it lost many of these in a natural way. The gamekeepers said that losing the feathers from the feet was a sure sign that the bird was diseased; but as all kinds of grouse more or less lost these feathers about that time of year, this indication of disease fell to the ground, and it had to be admitted that there really was no definition of grouse disease which was acceptable either to the pathologist or to the helminthologist. The action of 'Land and Water,' in proposing to send diseased grouse to M. Pasteur for examination, had caused great excitement in some quarters, but he would venture to say that, as it was impossible to keep these wild birds healthy in confinement for any length of time (after undergoing the journey from Scotland to Paris) the conditions would not be favourable for the formation of an opinion of great value. What he suggested to the owners of moors was that some professed bacteriologist should proceed to the affected districts and examine the matter on the spot—at their expense, not at his own.

The President said that the Fellows would probably remember Prof. Bell's remarks upon the subject last winter, and his exhibition of the actual tape-worms which he had then found. They would not fail, therefore, to be much interested by his additional very practical and interesting series of remarks.

Mr. J. G. Grenfell's paper "On New Species of *Scyphidia* and *Dinophysis*" was read (*supra*, p. 558).

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—*Bulbochæte gigantea* in fruit.

Mr. Crisp:—Hooke Microscope.

Dr. Crookshank:—Series of Cultivations of Micro-organisms.

Mr. Eve:—*Actinomyces* from jaw of ox.

Mr. Freeman:—Series-sections of the anatomy of spiders, worms, &c.

New Fellows:—The following were elected *Ordinary* Fellows:—
Messrs. William Ball, Henry F. Dale, and George Day.

1887. Part 5.

OCTOBER.

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Price 5s.

JOURNAL OF THE ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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FELLOWS OF THE SOCIETY.



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I.—APERTURE TABLE.

Numerical Aperture. ($n \sin u = a$)	Corresponding Angle (2 u) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2)	Pene- trating Power. ($\frac{1}{a}$)
	Air ($n = 1.00$).	Water ($n = 1.33$).	Homogeneous Immersion ($n = 1.52$).	White Light. ($\lambda = 0.5269 \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0.4861 \mu$, Line F.)	Photography. ($\lambda = 0.4000 \mu$, near Line h.)		
1.52	180° 0'	146,543	158,845	193,037	2.310	.658
1.51	166° 51'	145,579	157,800	191,767	2.280	.662
1.50	161° 23'	144,615	156,755	190,497	2.250	.667
1.49	157° 12'	143,651	155,710	189,227	2.220	.671
1.48	153° 39'	142,687	154,665	187,957	2.190	.676
1.47	150° 32'	141,723	153,620	186,687	2.161	.680
1.46	147° 42'	140,759	152,575	185,417	2.132	.685
1.45	145° 6'	139,795	151,530	184,147	2.103	.690
1.44	142° 39'	138,830	150,485	182,877	2.074	.694
1.43	140° 22'	137,866	149,440	181,607	2.045	.699
1.42	138° 12'	136,902	148,395	180,337	2.016	.704
1.41	136° 8'	135,938	147,350	179,067	1.988	.709
1.40	134° 10'	134,974	146,305	177,797	1.960	.714
1.39	132° 16'	134,010	145,260	176,527	1.932	.719
1.38	130° 26'	133,046	144,215	175,257	1.904	.725
1.37	128° 40'	132,082	143,170	173,987	1.877	.739
1.36	126° 58'	131,118	142,125	172,717	1.850	.735
1.35	125° 18'	130,154	141,080	171,447	1.823	.746
1.34	123° 40'	129,189	140,035	170,177	1.796	.741
1.33	..	180° 0'	122° 6'	128,225	138,989	168,907	1.769	.752
1.32	..	165° 56'	120° 33'	127,261	137,944	167,637	1.742	.758
1.31	..	160° 6'	119° 3'	126,297	136,899	166,367	1.716	.763
1.30	..	155° 38'	117° 35'	125,333	135,854	165,097	1.690	.769
1.29	..	151° 50'	116° 8'	124,369	134,809	163,827	1.664	.775
1.28	..	148° 42'	114° 44'	123,405	133,764	162,557	1.638	.781
1.27	..	145° 27'	113° 21'	122,441	132,719	161,287	1.613	.787
1.26	..	142° 39'	111° 59'	121,477	131,674	160,017	1.588	.794
1.25	..	140° 3'	110° 39'	120,513	130,629	158,747	1.563	.800
1.24	..	137° 36'	109° 20'	119,548	129,584	157,477	1.538	.806
1.23	..	135° 17'	108° 2'	118,584	128,539	156,207	1.513	.813
1.22	..	133° 4'	106° 45'	117,620	127,494	154,937	1.488	.820
1.21	..	130° 57'	105° 30'	116,656	126,449	153,668	1.464	.826
1.20	..	128° 55'	104° 15'	115,692	125,404	152,397	1.440	.833
1.19	..	126° 58'	103° 2'	114,728	124,359	151,128	1.416	.840
1.18	..	125° 3'	101° 50'	113,764	123,314	149,857	1.392	.847
1.17	..	123° 13'	100° 33'	112,799	122,269	148,588	1.369	.855
1.16	..	121° 26'	99° 29'	111,835	121,224	147,317	1.346	.862
1.15	..	119° 41'	98° 20'	110,872	120,179	146,048	1.323	.870
1.14	..	118° 0'	97° 11'	109,907	119,134	144,777	1.300	.877
1.13	..	116° 20'	96° 2'	108,943	118,089	143,508	1.277	.885
1.12	..	114° 44'	94° 55'	107,979	117,044	142,237	1.254	.893
1.11	..	113° 9'	93° 47'	107,015	115,999	140,968	1.232	.901
1.10	..	111° 36'	92° 43'	106,051	114,954	139,698	1.210	.909
1.09	..	110° 5'	91° 38'	105,087	113,909	138,428	1.188	.917
1.08	..	108° 36'	90° 34'	104,123	112,864	137,158	1.166	.926
1.07	..	107° 8'	89° 30'	103,159	111,819	135,888	1.145	.935
1.06	..	105° 42'	88° 27'	102,195	110,774	134,618	1.124	.943
1.05	..	104° 16'	87° 24'	101,231	109,729	133,348	1.103	.952
1.04	..	102° 53'	86° 21'	100,266	108,684	132,078	1.082	.962
1.03	..	101° 30'	85° 19'	99,302	107,639	130,808	1.061	.971
1.02	..	100° 10'	84° 18'	98,338	106,593	129,538	1.040	.980
1.01	..	98° 50'	83° 17'	97,374	105,548	128,268	1.020	.990
1.00	180° 0'	97° 31'	82° 17'	96,410	104,503	126,998	1.000	1.000
0.99	168° 48'	96° 12'	81° 17'	95,446	103,458	125,728	.980	1.010
0.98	157° 2'	94° 56'	80° 17'	94,482	102,413	124,458	.960	1.020
0.97	151° 52'	93° 40'	79° 18'	93,518	101,368	123,188	.941	1.031
0.96	147° 29'	92° 24'	78° 20'	92,554	100,323	121,918	.922	1.042
0.95	143° 36'	91° 10'	77° 22'	91,590	99,278	120,648	.903	1.053
0.94	140° 6'	89° 56'	76° 24'	90,625	98,233	119,378	.884	1.064
0.93	136° 52'	88° 44'	75° 27'	89,661	97,188	118,108	.865	1.075
0.92	133° 51'	87° 32'	74° 30'	88,697	96,143	116,838	.846	1.087
0.91	131° 0'	86° 20'	73° 33'	87,733	95,098	115,568	.828	1.099
0.90	128° 19'	85° 10'	72° 36'	86,769	94,053	114,298	.810	1.111
0.89	125° 45'	84° 0'	71° 40'	85,805	93,008	113,028	.792	1.124
0.88	123° 17'	82° 51'	70° 44'	84,841	91,963	111,758	.774	1.136

APERTURE TABLE—continued.

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2 .)	Penetrating Power. ($\frac{1}{a}$.)
	Air ($n = 1.00$.)	Water ($n = 1.33$.)	Homogeneous Immersion ($n = 1.52$.)	White Light. ($\lambda = 0.5269 \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0.4861 \mu$, Line F.)	Photography. ($\lambda = 0.4000 \mu$, near Line A.)		
0.87	120° 55'	81° 42'	69° 49'	83,877	90,918	110,488	·757	1.149
0.86	118° 38'	80° 34'	68° 54'	82,913	89,873	109,218	·740	1.163
0.85	116° 25'	79° 37'	68° 0'	81,949	88,828	107,948	·723	1.176
0.84	114° 17'	78° 20'	67° 6'	80,984	87,783	106,678	·706	1.190
0.83	112° 12'	77° 14'	66° 12'	80,020	86,738	105,408	·689	1.203
0.82	110° 10'	76° 8'	65° 18'	79,056	85,693	104,138	·672	1.222
0.81	108° 10'	75° 3'	64° 24'	78,092	84,648	102,868	·656	1.233
0.80	106° 16'	73° 58'	63° 30'	77,128	83,603	101,598	·640	1.250
0.79	104° 22'	72° 53'	62° 38'	76,164	82,558	100,328	·624	1.266
0.78	102° 31'	71° 49'	61° 45'	75,200	81,513	99,058	·608	1.282
0.77	100° 42'	70° 45'	60° 52'	74,236	80,468	97,788	·593	1.299
0.76	98° 56'	69° 42'	60° 0'	73,272	79,423	96,518	·578	1.316
0.75	97° 11'	68° 40'	59° 8'	72,308	78,378	95,248	·563	1.333
0.74	95° 28'	67° 37'	58° 16'	71,343	77,333	93,979	·548	1.351
0.73	93° 46'	66° 34'	57° 24'	70,379	76,288	92,709	·533	1.370
0.72	92° 6'	65° 32'	56° 32'	69,415	75,242	91,439	·518	1.389
0.71	90° 28'	64° 32'	55° 41'	68,451	74,197	90,169	·504	1.408
0.70	88° 51'	63° 31'	54° 50'	67,487	73,152	88,899	·490	1.429
0.69	87° 16'	62° 30'	53° 59'	66,523	72,107	87,629	·476	1.449
0.68	85° 41'	61° 30'	53° 9'	65,559	71,062	86,359	·462	1.471
0.67	84° 8'	60° 30'	52° 18'	64,595	70,017	85,089	·449	1.493
0.66	82° 36'	59° 30'	51° 28'	63,631	68,972	83,819	·436	1.515
0.65	81° 6'	58° 30'	50° 38'	62,667	67,927	82,549	·423	1.538
0.64	79° 36'	57° 31'	49° 48'	61,702	66,882	81,279	·410	1.562
0.63	78° 6'	56° 32'	48° 58'	60,738	65,837	80,009	·397	1.587
0.62	76° 38'	55° 34'	48° 9'	59,774	64,792	78,739	·384	1.613
0.61	75° 10'	54° 36'	47° 19'	58,810	63,747	77,469	·372	1.639
0.60	73° 44'	53° 38'	46° 30'	57,846	62,702	76,199	·360	1.667
0.59	72° 18'	52° 40'	45° 40'	56,881	61,657	74,929	·348	1.695
0.58	70° 54'	51° 42'	44° 51'	55,918	60,612	73,659	·336	1.724
0.57	69° 30'	50° 45'	44° 2'	54,954	59,567	72,389	·325	1.754
0.56	68° 6'	49° 48'	43° 14'	53,990	58,522	71,119	·314	1.786
0.55	66° 44'	49° 51'	42° 25'	53,026	57,477	69,849	·303	1.818
0.54	65° 22'	47° 54'	41° 37'	52,061	56,432	68,579	·292	1.852
0.53	64° 0'	46° 58'	40° 48'	51,097	55,387	67,309	·281	1.887
0.52	62° 40'	46° 2'	40° 0'	50,133	54,342	66,039	·270	1.923
0.51	61° 20'	45° 6'	39° 12'	49,169	53,297	64,769	·260	1.961
0.50	60° 0'	44° 10'	38° 24'	48,205	52,252	63,499	·250	2.000
0.48	57° 22'	42° 18'	36° 49'	46,277	50,162	60,959	·230	2.083
0.46	54° 47'	40° 28'	35° 15'	44,349	48,072	58,419	·212	2.174
0.45	53° 30'	39° 33'	34° 27'	43,385	47,026	57,149	·203	2.222
0.44	52° 13'	38° 38'	33° 40'	42,420	45,981	55,879	·194	2.273
0.42	49° 40'	36° 49'	32° 5'	40,492	43,891	53,339	·176	2.381
0.40	47° 9'	35° 0'	30° 31'	38,564	41,801	50,799	·160	2.500
0.38	44° 40'	33° 12'	28° 57'	36,636	39,711	48,259	·144	2.632
0.36	42° 12'	31° 24'	27° 24'	34,708	37,621	45,719	·130	2.778
0.35	40° 58'	30° 30'	26° 38'	33,744	36,576	44,449	·123	2.857
0.34	39° 44'	29° 37'	25° 51'	32,779	35,531	43,179	·116	2.941
0.32	37° 20'	27° 51'	24° 18'	30,851	33,441	40,639	·102	3.125
0.30	34° 56'	26° 4'	22° 46'	28,923	31,351	38,099	·090	3.333
0.28	32° 32'	24° 18'	21° 14'	26,995	29,261	35,559	·078	3.571
0.26	30° 10'	22° 33'	19° 42'	25,067	27,171	33,019	·068	3.846
0.25	28° 58'	21° 40'	18° 56'	24,103	26,126	31,749	·063	4.000
0.24	27° 46'	20° 48'	18° 10'	23,138	25,081	30,479	·058	4.167
0.22	25° 26'	19° 2'	16° 38'	21,210	22,991	27,940	·048	4.545
0.20	23° 4'	17° 18'	15° 7'	19,282	20,901	25,400	·040	5.000
0.18	20° 44'	15° 34'	13° 36'	17,354	18,811	22,860	·032	5.555
0.16	18° 24'	13° 50'	12° 5'	15,426	16,721	20,320	·026	6.250
0.15	17° 14'	12° 58'	11° 19'	14,462	15,676	19,050	·023	6.667
0.14	16° 5'	12° 6'	10° 34'	13,498	14,630	17,780	·020	7.143
0.12	13° 47'	10° 22'	9° 4'	11,570	12,540	15,240	·014	8.333
0.10	11° 29'	8° 38'	7° 34'	9,641	10,450	12,700	·010	10.000
0.08	9° 11'	6° 54'	6° 3'	7,713	8,360	10,160	·006	12.500
0.06	6° 53'	5° 10'	4° 32'	5,785	6,270	7,620	·004	16.667
0.05	5° 44'	4° 18'	3° 46'	4,821	5,225	6,350	·003	20.000

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			£ s. d.					
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101	3 inches	7	1 10 0					
102	3 inches	12	2 10 0	15	24	45	60	75
103	2 inches	10	1 10 0					
104	2 inches	17	2 10 0	22	36	67	90	112
105	1½ inch	23	2 10 0	30	48	90	120	150
106	1 inch	25	2 0 0					
107	1 inch	32	2 10 0	70	112	210	280	350
108	1 inch	45	2 10 0	100	160	300	400	500
109	¾ inch	65	4 0 0	125	200	375	500	625
110	¾ inch	95	5 0 0	150	240	450	600	750
111	¾ inch	75	3 10 0	200	320	600	800	1000
112	½ inch	120	4 10 0	250	400	750	1000	1250
113	½ inch	130	5 0 0	400	640	1200	1600	2000
114	⅓ imm.	180	5 5 0	500	800	1500	2000	2500
115	⅓ imm.	180	8 0 0	750	1200	2250	3000	3750
116	⅓ imm.	180	10 0 0	1000	1600	3000	4000	5000
117	⅓ inch	160	20 0 0	2000	3200	6000	8000	10,000

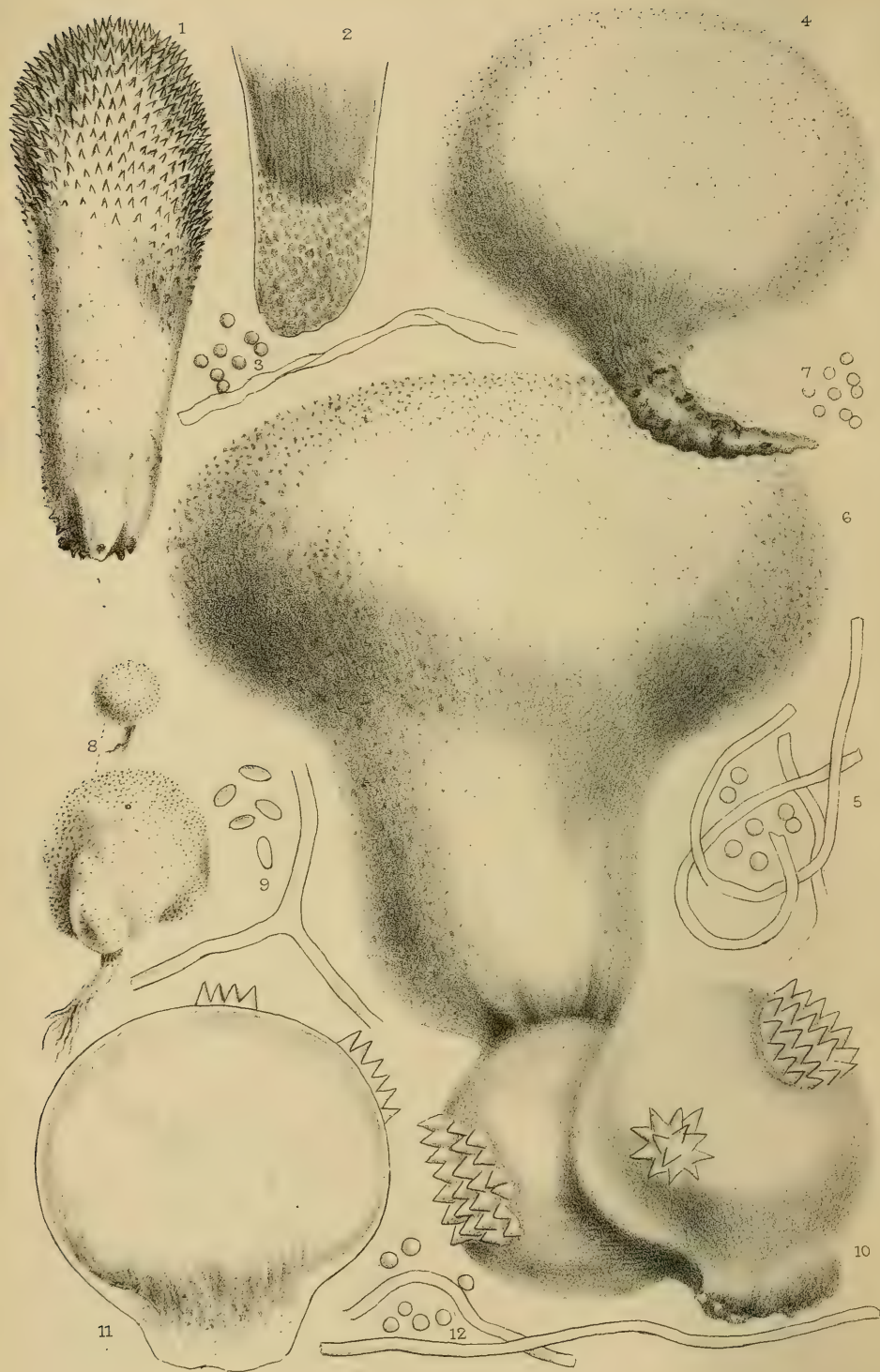
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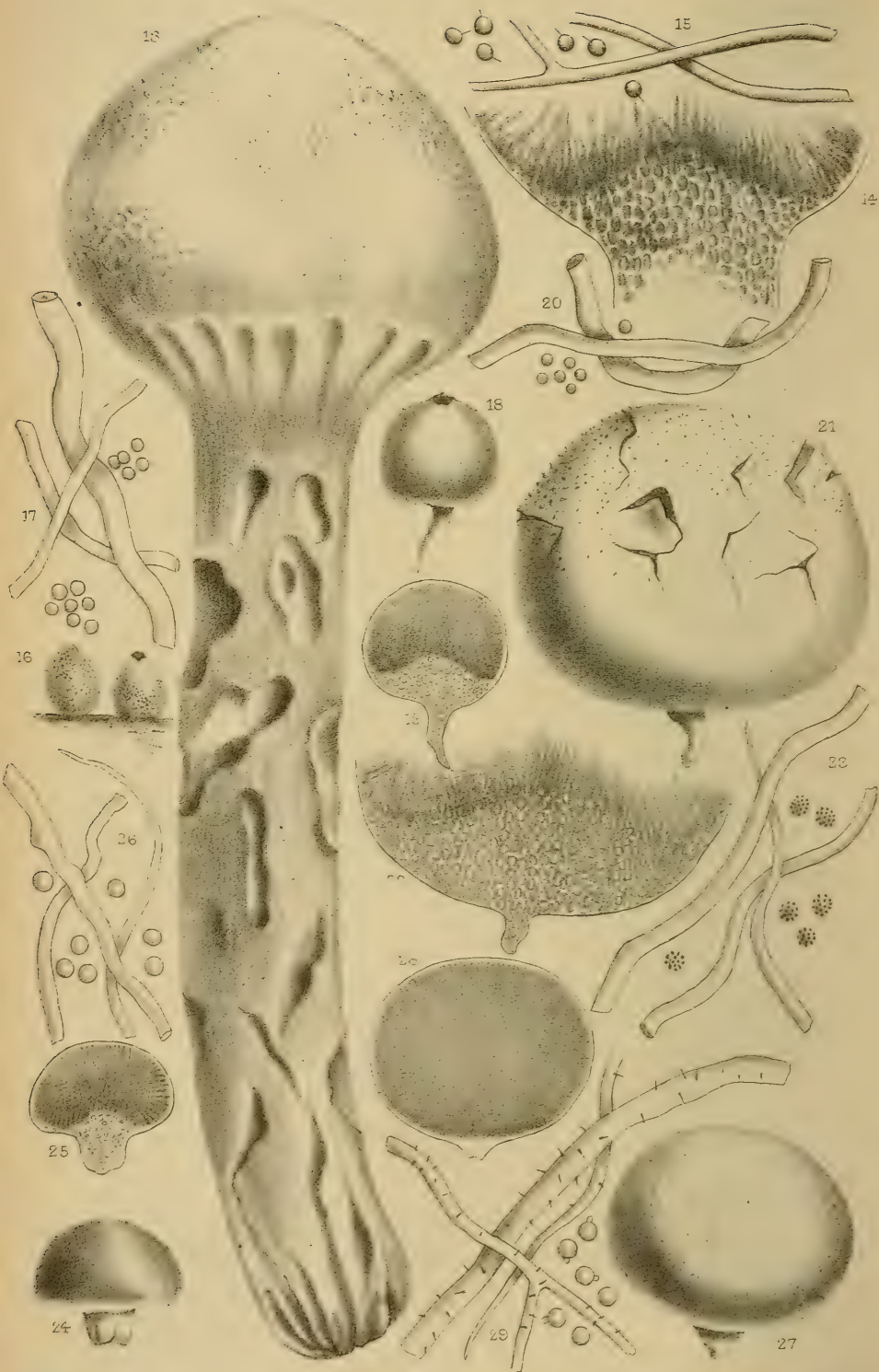
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JOURNAL
OF THE
ROYAL MICROSCOPICAL SOCIETY.

OCTOBER 1887.

TRANSACTIONS OF THE SOCIETY.

XII.—*A Monograph of the Genus Lycoperdon (Tournef.) Fr.*

By G. MASSEE, F.R.M.S.

(Read 8th June, 1887.)

PLATES XII. AND XIII.

THE earliest systematic account of the genus *Lycoperdon* is contained in Fries' 'Systema Mycologicum,' published in 1829, where nine species are described, including *L. Brasiliense* Fr., the only extra-European species then known. Afterwards (1841) Vittadini published his 'Monographia Lycoperdineorum,' in which sixteen species, all European, are described. Of these, two have been removed to the allied genus *Bovista*. During the past forty years, botanical research in every quarter of the globe has added over one hundred additional species, the Rev. M. J. Berkeley alone,

EXPLANATION OF PLATES XII. AND XIII.

- Fig. 1.—*Lycoperdon Colensoi* Cke. & Mass.; nat. size.
" 2.—Section of base of same; nat. size.
" 3.—Spores and threads of same; $\times 400$.
" 4.—*L. Capense* Cke. & Mass.; nat. size.
" 5.—Spores and threads of same; $\times 400$.
" 6.—*L. Berkeleyi* Mass.; nat. size.
" 7.—Spores of same; $\times 400$.
" 8.—*L. oblongisporum* Berk. & Curt.; nat. size.
" 9.—Spores and thread of same; $\times 400$.
" 10.—*L. stellatum* Cke. & Mass.; nat. size.
" 11.—Vertical section of same; nat. size.
" 12.—Spores and threads of same; $\times 400$.
" 13.—*L. clatum* Mass.; nat. size.
" 14.—Section of base of peridium of same; nat. size.
" 15.—Spores and threads of same; $\times 400$.
" 16.—*L. calyptraforme* Berk.; nat. size.
" 17.—Spores and threads of same; $\times 400$.
" 18.—*L. Natalense* Cke. & Mass.; nat. size.
" 19.—Section of same; nat. size.
" 20.—Spores and threads of same; $\times 400$.
" 21.—*L. violascens* Cke. & Mass.; nat. size.
" 22.—Section of base of same; nat. size.
" 23.—Spores and threads of same; $\times 400$.
" 24.—*L. Cookei* Mass.; nat. size.
" 25.—Section of same; nat. size.
" 26.—Spores and threads of same; $\times 400$.
" 27.—*L. flavum* Mass.; nat. size.
" 28.—Section of same; nat. size.
" 29.—Spores and threads of same; $\times 400$.

or jointly with other authors, having described forty-four new forms. The present paper contains descriptions of one hundred and twenty-nine species, forty-nine of which are European, if Bonorden's imperfectly described species are included.

The genus is cosmopolitan, extending from Disco Island, 70° N. lat., to the extreme south of New Zealand, 47° S. lat. It occurs in all low-land tropics, and ascends the Himalayas to between seven and eight thousand feet, where *L. gemmatum* Batsch, a common British species, was collected by Dr. (now Sir Joseph) Hooker. Eighty-five species are confined to the northern hemisphere, twenty-seven to the southern, and fifteen are common to both. Ten species are peculiar to Cuba, and seven to Ceylon. *L. pusillum* Batsch, a common British species about the size of a marble, is represented in the Royal Herbarium, Kew, from Europe, Tropical and South Africa, Lower Pegu, East Nepaul, China, Java, Ceylon, Bonin Islands, North America, South America, Australia, and New Zealand.

The species vary much in colour, shape, and surface texture at different ages, being usually white, and warted or spinose when young, becoming brownish or silvery with age, and frequently perfectly smooth, owing to the falling away of the "cortex"; hence the difficulty, in the absence of type specimens or figures, of ascertaining exactly what species correspond to the meagre descriptions, drawn up almost entirely from external characters, by the pioneers of mycology, who in many instances have given different names to the same species at various stages of growth. Vittadini was the first to employ microscopic along with external characters in the discrimination of species, and he appears to have considered that when once the structure had been worked out, external characters alone were sufficient for the recognition of the species, as three specimens sent to the Rev. M. J. Berkeley as *L. defossum* Vitt., and which externally presented no differences, proved on microscopic examination to be three distinct species: one the true plant intended, another with coarsely warted spores, and the third imperfect, but with a well-developed sterile basal stratum, and smooth spores almost twice the size of those in the species intended.

The spores are supported on pedicels or sterigmata springing from basidia, and in some species the pedicels break away from the basidia and remain attached to the spores, a character considered by Peck, in his arrangement of the United States species of *Lycoperdon*, as being of primary importance; but the examination of a large series of specimens proves this character to be of little or no value, the persistence of the pedicels depending entirely on the relative development of the specimen when collected, and in almost every instance where the plants have been for many years in the herbarium, the pedicels have broken away. The spores are very constant in size, shape, surface marking, and colour, but the last character is only of specific value when the plant is quite ripe, and the spores readily fall out of the ruptured peridium, as in almost every instance they are at first some shade of yellow, and only attain the darker tints when ripe. The colour characters used in the present work refer to the tint of spores in the mass when thrown down on a white surface.

The threads of the capillitium afford good specific characters, depending on the mode of branching; their consistency, whether firm or collapsing when dry; and their thickness compared with the diameter of the spores. The colour of the capillitium is usually some shade of yellow or brown when the spores are thoroughly blown away.

The relative development of the sterile basal stratum varies much in different species, being frequently continued downwards into a more or less elongated stem-like base.

The species are arranged under the following groups:—

A. Sterile basal stratum, well developed, cellular or compact.

- I. Spores globose, rough, purple, lilac, or various shades of brown.
- II. Spores globose, rough, brownish olive, olive, or various shades of yellow.
- III. Spores globose, smooth, purple, lilac, or various shades of brown.
- IV. Spores globose, smooth, brownish olive, olive, or various shades of yellow.
- V. Spores elliptical or subglobose.

B. Sterile basal stratum, rudimentary or obsolete.

- I. Spores globose, rough, purple, lilac, or various shades of brown.
- II. Spores globose, rough, brownish olive, olive, or various shades of yellow.
- III. Spores globose, smooth, purple, lilac, or various shades of brown.
- IV. Spores globose, smooth, brownish olive, olive, or various shades of yellow.
- V. Spores elliptical or subglobose.

In attempting to unravel the synonymy of the old authors, it must be distinctly understood that references to figures only implies that they externally resemble the species under which they are placed, and it has already been shown that external characters alone are of little value.

I take this opportunity of acknowledging my great indebtedness, and also of tendering my best thanks, to Dr. M. C. Cooke for the valuable assistance rendered during the preparation of this paper.

Lycoperdon (Tournef.), Fries, Syst. Myc., iii. p. 27.—Peridium membranaceous, single, the subpersistent cortex becoming broken up into warts or spines, dehiscent by a small apical mouth, or the whole of the upper part evanescent. Capillitium dense, springing from the more or less developed sterile basal stratum; spores globose or elliptic, externally rough or smooth.

The genus was founded by Tournefort,* who included under it a heterogeneous assemblage of Trichogastres, Fries being the first to use it

* Inst. R. Herb., p. 563.

in the restricted sense as defined here. *Bovista* differs in having the capillitium springing from every part of the peridium, in the more compact nature of the cortex, and in the entire absence of a sterile basal stratum. The last-mentioned character, along with the thick corky peridium, separates *Scleroderma*. *Tulostoma* differs in having the peridium distinct from the stem, and *Hippoperdon* in the labyrinthiform arrangement of the capillitium, which is adnate to the peridium on all sides.

A. *Sterile basal stratum well developed, cellular or compact.*

I. *Spores globose, rough, purple, lilac, or various shades of brown.*

1. *L. Hoylei*, B. & Br., Ann. Nat. Hist., No. 1037.—Peridium stipitate, subglobose, densely covered with long purple-brown stout spines, stem stout, spinulose, inner substance bright olive, root of long white fibres. Capillitium dense, thickest threads wider than diameter of spores, sparsely branched, passing into the compact sterile portion; spores bright lilac, globose, warted, $5\ \mu$, often furnished with a long hyaline pedicel.

Stem from $1/2$ to 1 in. long, $3/4$ in. thick; peridium, 2 in. diam.

Resembling *L. echinatum* in general appearance, differing in the presence of a stem, the colour and size of the spores, and in the very compact non-cellular sterile stratum.

England (Reading). Oct.

2. *L. echinatum*, Pers. Symb. Myc., p. 36.—Peridium obovate, covered with long stout purple-brown spines, between which are minute mealy warts of the same colour, root consisting of long white fibres. Capillitium purple-umber, dense, persistent, barren basal portion well developed, cellular, pale ochre, threads about equal to diameter of spores, much branched; spores purple-umber, spherical, strongly warted, $6\ \mu$ diam.—Pers. Syn., 147. *L. gemmatum* γ *echinatum*, Fr. G. M., iii. p. 37. *Utraria echinata*, Quel. Champ. Jur. et Vosg., ii. t. 3. Rabenh. Krypt. Fl., figs. 1–2, p. 894.

The spines are often curved, and when they have fallen away, the peridium presents a tessellated appearance, due to the pale scars being surrounded by the small persistent dark warts.

From $1/2$ – $1\frac{1}{2}$ in. diam. In woods amongst leaves, generally solitary. Autumn. Europe.

It is doubtful what species Peck has in view under the name of *L. echinatum* Pers., in U.S. Sp. Lycop., as he considers a distinguishing feature to be the smooth surface of the peridium after the spines have fallen off. It cannot be the true *echinatum* of Persoon.

3. *L. constellatum*, Fr. Syst. Myc., iii. 39.—Subglobose, or sub-turbinate and tapering towards the base, peridium membranaceous, persistent, clothed with stout, spreading reddish-brown spines; between the spines are minute warts of the same colour, which remain after the spines fall off, and form a reticulated pattern. Capillitium lax, threads firm, variable in thickness, branched, axils rounded, tapering, bright brown by transmitted light, sterile base cellular; spores purple-brown, globose, warted, sometimes stipitate, 5 – $6\ \mu$ diam.—*L. umbrinum*, Fl. Dan., MDCCC. Peck, N.Y. Nat. Hist. Mus. Bot. Report (29th), pl. 2, f. 13–14.

Related to *L. echinatum* and *L. Hoylei*; distinguished from the former by the much weaker spines and rounded axils of the branching threads, and from the latter by the absence of a true stem.

On the ground, amongst leaves. Europe, United States.

4. *L. pulcherrimum*, B. & C., Grev., ii. p. 51.—Broadly obovate, bristling with crowded whitish, stout, elongated pyramidal spines with minute warts between, base smooth and plicate. Capillitium dense, threads usually thicker than diameter of spores, firm, branched, tapering, sterile base cellular, well developed; spores brownish purple, globose, very minutely warted, usually pedicellate, $5\ \mu$ diam.

About 1 in. in diam. On the ground. Pennsylvania.

In the original description of this species, the spores are described as being *smooth* and *olive*. The specimens received by Berkeley, and from which the specific character was drawn up, are still in that gentleman's herbarium in excellent preservation, and are one of the many examples met with, in going over the specimens, of a change in colour, always verging on purple, having taken place in the spores after drying. The very minute warts may possibly have been overlooked in the first instance. As the spines on the peridium become old and dry, they have a tendency to split up in a fibrillose manner from the base.

5. *L. Frostii*, Pk. U.S. Sp. Lycop., p. 17.—Peridium subglobose, 1–2 in. broad, generally narrowed into a short stem-like base, echinate or shaggy, with long, stout, whitish spines, which are generally curved or stелately united, and which at length fall off and leave the peridium brown and smooth. Capillitium and spores purplish brown; spores rough, $0\cdot00016$ – $0\cdot0002$ in. (= about $5\ \mu$) in diam.

Said to differ from *L. constellatum* in its longer paler spines, and in having the denuded peridium smooth.

In the absence of specimens it is impossible to say with certainty, but I strongly suspect that this species is the same as *L. pulcherrimum* B. & C. See notes under last-mentioned species.

Ground in meadows. United States.

6. *L. hirtum*, Mart. Crypt. Erl., p. 386.—Broadly turbinate, contracted into a rather thick root; peridium thin, persistent, densely covered with soft slender spines, which fall away, leaving a smooth, non-reticulated surface, reddish umber, mouth small. Capillitium dense, threads firm, thickness variable, tapering, branched, axils rounded, sterile base well developed, slightly cellular; spores brownish purple, globose, minutely warted, $5\ \mu$.—*L. umbrinum* γ *hirtum*, Pers. Syn., 147–148 (*non* Bon.). *Utraria hirta*, Quel. Jur. et Vosg., 358.

From $1\frac{1}{2}$ –2 in. high. On the ground. Europe.

7. *L. atropurpureum*, Vitt. Lycop., 186.—Peridium thin, flaccid, subglobose or pyriform, stipitate or sessile, base more or less plicate, with slender spinules, becoming glabrous above, dehiscing by a minute irregular mouth, brownish above, becoming paler downwards, spinules darker. Capillitium continuous with the well-developed cellular sterile base; spores blackish purple, spherical, warted, sometimes pedicellate, 6 – $7\ \mu$ diam.—Vitt., t. 2, f. 6. *L. esculentum*, &c., Mich. Gen., t. 97, f. 4. *L. quercinum*, Pers. Syn., pp. 147–8. *L. atropurpureum*, Sci. Gossip, Dec. 1866. Cke. Hdbk., 1085.

Size variable, from 1-2½ in. across. In oak woods, &c. Autumn. Europe, United States.

8. *L. velatum*, Vitt. Lycop., p. 187.—Peridium subglobose or turbinate, umbonate, with a rooting base, flaccid, cortex at first continuous, white then pallid, becoming broken up into irregular adnate patches with fibrillose margins, between the patches ochraceous with minute persistent warts, dehiscing by a minute aperture. Capillitium dense, floccose, threads rarely branched, thicker than diameter of spores, tapering, continuous with the compact minutely cellular sterile base; spores olive, then brownish purple, spherical, warted, sometimes pedicellate, 4-5 μ diam.—Vitt. Lycop., t. 2, fig. 3. *L. album*, &c., Mich. Gen., t. 97, f. 2. *L. mammæforme*, Pers. Syn., 145. *L. lanatum*, Batsch, Elench., p. 147. *Utraria velata*, Quel. Champ. Jur. et Vosg., 358.

From 1 to 2 in. diam. In oak woods. Autumn. Italy, France.

9. *L. cyathiforme*, Bosc., in Berlin Mag., lxxxvii., t. 6, f. 11.—Subglobose, peridium thick, cortex mealy, becoming broken up into angular adnate patches, root stout, elongated. Threads of capillitium rather thinner than diameter of spores, lax, branching, axils acute, tapering, sterile base cellular; spores brownish purple, globose, strongly warted, often pedicellate, 8 μ diam.—Ravenel, Fungi Carol. Exs., No. 4.

Rather more than 1 in. across. On the ground, in sandy places in pine woods. Europe, Somerset East, South Africa, North America.

10. *L. lilacinum* (Berk.) Mass.—Broadly obovate or turbinate, and contracted into a stout cellular stem-like base. Peridium thin and evanescent above, dehiscing by a large irregular opening, cortex white, polished, breaking away in papery patches. Threads of capillitium thinner than diameter of spores, flaccid, simple, continuous with the convex cellular sterile basal stratum; spores violet, with a tinge of ochre, echinulate, globose, 6 μ .—*Bovista lilacina*, Berk. & Mont., Hook. Lond. Journ., 1845.

From 2-4 in. high, and 2-3 in. broad. On the ground. Australia, Tasmania, Ceylon, Madras.

11. *L. violascens* Cke. & Mass., nov. sp.—Globose, sessile, sometimes rather plicate below, and terminating in a short slender root. Peridium papyraceous, persistent, at first covered with minute granular warts, becoming smooth and shining, persistently white, dehiscing above by a large irregular opening. Threads of capillitium variable in thickness, often nodulose, tapering, free from the large, convex, cellular sterile base; spores lilac, globose, minutely warted, 6 μ . Plate XIII. figs. 21-23.

About 1½ in. across. On the ground. Australia.

12. *L. Curreyi* Mass.—Globoso-depressed passing into a short thick stem, or subturbinate, with a long thick root, peridium papyraceous, fragile, almost smooth, the upper part breaking away in patches, leaving a cup-shaped opening with an irregular margin. Threads of capillitium thin, rarely branched, colourless by transmitted light, sterile base well developed, cellular; spores violet, globose, minutely warted, 6 μ in diam.—*L. radiculatum*, Welw. & Curr., Fung. Angol., Trans. Linn. Soc., xxvi. p. 289, tab. 20, figs. 8-9 (1868). There is a *L. radiculatum* D. R. & Mont. of slightly prior date.

3-4 in. high, 2-4 in. broad. In grassy places amongst bushes. Loanda, West Africa, Cape of Good Hope.

13. *L. fucatum*, Lev. Ann. Sci. Nat., 1844, 219.—Sessile, subglobose, glabrous, white. Capillitium continuous with the cellular sterile base, threads firm, thin, flexuous, frequently branched, axils rounded; spores dark lilac, becoming vinous brown, globose, strongly echinulate, $5\ \mu$.—Lev. in Voy. Bonite, t. 140, f. 3.

From 1–2 in. diam. On the ground and on old trees, &c. Monte Video, New Mexico, East Nepal, Ceylon.

14. *L. fragile*, Vitt. Mon., p. 180.—Peridium thin, very fragile, evanescent above, subglobose or pyriform, more or less plicate below, irregularly rooting, minutely warted or submentose, becoming almost glabrous from ochraceo-cinereous to brownish purple. Capillitium continuous with the subcompact floccose basal sterile portion; spores passing from bright ochre to blackish purple, globose, minutely warted, $5\ \mu$ diam.—*L. bovista*, Vitt. Mang., t. 3, f. 2.

Vittadini says that it varies in size from a walnut to that of the closed hand. When old the capillitium disappears, and the peridium stands up like a cup, with the margin irregularly laciniated.

Grassy places. Summer and autumn. Italy, Algeria.

15. *L. Caffrorum*, K. & C., Grev., x. p. 109 (1882).—Peridium turbinate-globose, 2–3 in. diam., base attenuated, rooting, at first almost smooth, then broken up into minute scales, ferruginous brown. Capillitium continuous with the sterile base; spores echinulate, brownish.

Somewhat resembling *L. Gardneri* B., but smaller, deeper coloured, and spores not so rough.

Somerset East, South Africa.

16. *L. glabellum* Peck, N.Y. Nat. Hist. Mus. Bot. Report (31st), p. 39.—Subglobose or turbinate, sometimes narrowed below into a short stem-like base, yellow or brownish yellow, furfuraceous with minute nearly uniform persistent warts; capillitium and spores purplish brown, columella present; spores rough, $0\cdot0002$ – $0\cdot00025$ in. diam. (= about $6\ \mu$).—U.S. Sp. Lycop., p. 20.

From $2/3$ to $1\frac{1}{2}$ in. in diam. Ground in pine woods and bushy places. United States, Somerset East, South Africa.

17. *L. asterospermum*, D. R. & Mont., Fl. Algér., 379.—Peridium obovate-pyriform, dirty rufous, rather rigid above, flaccid below, covered with minute crowded spinose warts; dehiscing by a well-defined small circular mouth; root long, tapering. Capillitium continuous with the yellowish floccose minutely cellular sterile base, threads often nodulose, branched, axils acute, varying in thickness, tapering; spores brownish purple, globose, warted, $7\ \mu$ diam.

Externally resembling *L. pyriforme*, about 1 in. across. In sandy woods. Algeria.

18. *L. decipiens*, D. R. & M., Fl. Alg., 380.—Peridium membranaceous, flaccid, obovate at first with spinulose warts, becoming smooth, dark grey and shining, dehiscing by a small lacerated orifice, root tapering. Capillitium continuous with the copious very cellular sterile stratum; threads branched, axils rounded, thinner than diameter of spores, often verrucose, tapering; spores purple-umber, globose, warted, $6\ \mu$ diam.

About $3/4$ in. diam. On the ground. Algeria.

19. *L. cupricum*, Bon. Bot. Ztg., 1857, 625.—Peridium obconic, depressed, plicate below, tapering to an acuminate rooting base, at first greyish flesh colour, then coppery, becoming umbonate, and dehiscing by a small laciniate mouth. Spores purple-umber, spinulose.

In shady woods. Germany.

20. *L. elongatum*, Berk. Hook. Journ., vi. (1854) 171.—Stipitate; peridium obovate, minutely verrucose, dehiscing by a large opening, stem long, thick, tapering downwards. Threads of capillitium flexuous, branching at wide angles, axils acute, sterile portion cellular; spores umber, globose, strongly echinulate, $6\ \mu$ diam.

Stem 2 in. high, $3/4$ in. thick above. On the ground, amongst moss. Nepaul and Sikkim Himalayas.

II. Spores globose, rough, brownish olive, olive, or various shades of yellow.

21. *L. saccatum*, Vahl. Fl. Dan., t. 1139.—Stipitate, spherico-depressed, obtuse, above with small spinulose warts becoming smaller and fibrillose below and on the stem, dehiscing by an irregular aperture; stem stout, more or less elongated, nearly equal, often more or less lacunose, cellular within. Capillitium compact, persistent, threads branched, axils not rounded, thinner than diameter of spores; sterile basal portion convex, cellular; spores olivaceous umber, strongly echinulate, spherical, $6\ \mu$ diam.—Fr. Syst. Myc., iii. 35. Cke., Fung. Brit. Excs., No. 214. Price, pl. 3, f. 14. Hussey, i. pl. 26. Sci.-Gossip, Dec. 1866. Cke. Hdbk., 1087. Krombh., t. 30, f. 11–12. *Utraria saccata*, Quel. Champ. Jur. et Vosg., 361.

Peridium 1–2 in. in diam., stem 2–3 in. long, 1 in. or more thick. In thickets and open woods, amongst moss. Europe, North America, Somerset East, South Africa.

22. *L. excipuliforme* Scop.—Peridium subglobose or depressed, passing into a stout stem, at first with spinose warts which partly disappear leaving the surface tomentose, stem rather plicate at the base. Threads of capillitium flexuous, rarely branched, continuous with the sterile cellular base; spores globose, dirty olive, minutely warted, $4\text{--}5\ \mu$ diam.—Vitt. Lyc., 193. Schaeff. Ic., t. 187. Bull., t. 450 and t. 475? Paulet, p. 121, t. cei. f. 6. Karst. Myc. Fenn., p. 362. Nees, Pilze, t. 11, f. 126. Sverig. Svamp., pl. lxxiii. Pers. Syn., 143. Pabst, Crypt. Fl., t. 23. *L. gemmatum* γ *excipuliforme*, Fr. S. M. iii. 37. *Utraria excipuliforme*, Quel. Champ. Jur. et Vosg., 360. *L. excipuliforme*, Vitt. Lyc., 193.

Variable in size, from 1–4 in. high. In woods and meadows. Europe.

23. *L. cinereum*, Bon. Bot. Ztg. 1857, 615.—Peridium capitate, umbonate, narrowed downwards into a stem-like base, at first livid-grey, verrucoso-floccose, becoming smooth and obscure brown. Spores globose, spinulose, olive.

In woods. Europe.

III. Spores globose, smooth, purple, lilac, or various shades of brown.

24. *L. marginatum*, Vitt. Lyc., 185. — Turbinate or broadly obconic, obtuse, bristling with various sized pyramidal spines becoming smaller downwards and eventually disappearing above, permanent below and defined by a marginate line; dehiscing by a small apical aperture; root elongated tapering. Capillitium continuous with the prominent convex cellular sterile base, and forming an imperfect columella, threads firm, rarely branched, mostly thicker than diameter of spores, tapering; spores purple-brown, smooth, globose, sometimes pedicellate, $5\ \mu$ diam. — Vitt. Lycop., t. 1, f. xi. *L. echini*, &c., Batt., t. 31, f. C. *L. papillatum*? Schaeff., t. 184.

An inch or more across. In sterile sandy places. Europe, Algeria.

25. *L. Natalense* Oke. & Mass., nov. sp. — Globose, sessile, passing abruptly into a short tapering root; peridium thick, minutely warted becoming smooth, mouth small, irregularly torn. Capillitium dense, free from the well-developed, convex, cellular sterile base, threads very thick, firm, flexuous, simple; spores olive with a tinge of purple, globose, smooth, $3\ \mu$ diam. Plate XIII. figs. 18–20.

From $1\frac{1}{2}$ – $2\frac{2}{3}$ in. diam. Ochraceous. On the ground. Quanda, Natal.

26. *L. bicolor*, Welw. & Curr., Fung. Angol., Trans. Linn. Soc., xxvi. p. 290, t. 20, f. 12. — Stipitate $1\frac{1}{2}$ –2 in. high, stem white, sub-cylindrical, attenuated towards the base; peridium brownish lead colour, papyraceous; capillitium brown; spores brown, globose, smooth, 5 – $6\ \mu$ diam.

In moist open places in woods. West Africa.

27. *L. aestivale*, Bon. Bot. Ztg., 1857, p. 630. — Peridium globose, granuloso-floccose, papyraceous, dehiscing by an irregularly toothed orifice, white, then brownish or greyish ochre; stem very short, stout, passing into the fusiform root. Capillitium fugacious, threads about equal to diameter of spores; sterile basal portion cellular, well developed; spores dark umber, globose, smooth, $6\ \mu$ diam.

Pileus $1\frac{1}{2}$ in. or more diam. Grassy places. August. Europe.

28. *L. rubecula*, B. & Br., Fungi Ceylon, No. 720, Journ. Linn. Soc., xiv. p. 80. — Peridium whitish, glabrous downwards, above with very minute rufous warts, conico-turbinate passing into the thick stem, which is more or less rugose at the base. Capillitium ochraceous, sterile portion well developed, spores ochraceous brown, globose, smooth, 3 – $4\ \mu$ diam.

On the ground. Ceylon.

Peridium with stem $2\frac{2}{3}$ –1 in. high. When dry altogether dirty ochraceous red, paler below. Mycelium fibrillose, white. In one of the types in Herb. Berk. the spores have a lilac tinge, and possibly they may be purplish when old.

29. *L. sericellum*, Berk., in Hook. Journ., 171. — Subglobose, obtuse, passing into a stout stem, silky or velvety, dehiscing by an apical aperture. Capillitium very dense, continuous with the compact silky sterile stratum, threads about equal in thickness to diameter of spores, branched, often nodulose; spores cinnamon, smooth, globose, $4\ \mu$ diam.

Peridium from 2 to 3 in. diam. On the ground. Darjeeling, India.

IV. *Spores smooth, globose, brownish olive, olive, or various shades of yellow.*

30. *L. elatum* Mass., nov. sp.—Stipitate, peridium globose, sub-umbonate, thin, with a few evanescent furfuraceous squamules, lacunose below; stem elongated, equal, cellular, lacunose. Capillitium dense, persistent, continuous with the copious cellular base, threads lax, thinner than diameter of spores, sparingly branched, firm; spores ferruginous-olive, globose, smooth, shortly pedicellate, $5\ \mu$ diam. Plate XIII. figs. 13–15.

In Herb. Berk. placed with *L. saccatum*, probably without examination. Allied to *L. perlatum*.

Peridium 2 in. across, stem 6 in. long, $\frac{2}{3}$ in. thick, reddish ochre when dry. On the ground. New England.

31. *L. perlatum*, Pers. Syn., p. 145.—Peridium variable, subglobose with an elongated stem, subglobose or depressed and nearly sessile, umbonate, ochraceous or dirty brown, at first covered with spinose warts, which are smaller downwards, disappearing with age, mouth small, torn, at apex of umbo. Capillitium continuous with the convex cellular sterile base and forming a columella, threads rarely branched, about equal in thickness to diameter of spores, flexuous; spores olivaceous, globose, smooth, $4\ \mu$ diam.—*L. perlatum*, Barla, pl. 46, f. 8. *L. gemmatum*, Fr. S. M., iii. 36. Sverig. Svamp., tab. lxxiii. Fl. Dan., mxxl. Krombh., t. 30, f. 6. Cke. Hdbk., 1088 (including *L. gemmatum*). Palist, Crypt. Fl., t. 23. *L. constellatum*, Sturm, t. 7? *L. lacunosum*, Bull., t. 52? *L. hirtum*, Bull., t. 340? *L. perlatum*, Vitt. Mon., 194. Allied to *L. gemmatum*, but readily distinguished by the umbonate mouth and distinct columella. The peridium is often plicate below, and the stem more or less lacunose. Often occurs in pairs from the same base.

In woods, especially of oak. Summer and autumn. Europe.

32. *L. gemmatum*, Batsch, Elench., p. 147.—Stipitate, subglobose, depressed above, or lens shaped, obtuse, with prominent spinose warts of various sizes, which eventually fall off, leaving the surface smooth and shining, dehiscing by a small opening; stem stout, tapering downwards. Capillitium continuous with the well-developed cellular sterile base, threads lax, rarely branching, axils acute, tapering; spores olivaceous umber, globose, smooth, $4\ \mu$ diam.—*L. gemmatum*, Hussey, i. pl. 54. Sci. Gossip, Dec. 1866. Eng. Flor., 304 (including *L. perlatum*). Karst. Myc. Fenn., iii. 361 (including *L. perlatum*). Cke. Hdbk., 1088 (including *L. perlatum*). *L. gemmatum* β *perlatum*, Fr. S. M., iii. 37. *Utraria gemmata*, Quel. Champ. Jur. et Vosg., p. 358.

Peridium 1–2 in. diam. Amongst grass, &c., in woods and shady places.

There is a form in Herb. Berk. from Sikkim Himalayas with the peridium fusiform, in some of the specimens elongated and not much thicker than the stem, but it agrees with the present species in the capillitium and spores, and is connected with the typical form by transitional states from various countries.

Europe, North America, Sikkim Himalayas (7–8000 ft.), Simla,

India, Tihri-Garhwal, N.W. India, Somerset East, South Africa, Algeria, Swan River, Illawarra, Solomon Islands, Tasmania, New Zealand.

33. *L. Berkeleyi* Mass.—Peridium subglobose or slightly depressed, delicate, prunioso-furfuraceous, stem stout, cellular. Threads of capillitium about equal in thickness to diameter of spores, branched, angles acute, free from the cellular base; spores ochraceous with a tinge of pink, smooth, globose, $3\ \mu$ diam.—*L. delicatum*, Berk. & Curt., Grev., ii. p. 51. There is a *L. delicatum* Berk. of prior date. Plate XII. figs. 6 and 7.

Peridium about $2\frac{1}{2}$ in. across, cellular stem-like base, $1-1\frac{1}{2}$ in. long and of equal thickness. Pennsylvania.

34. *L. Colensoi* Cke. and Mass., nov. sp.—Subcylindrical, peridium thin collapsing, dehiscing by a small apical torn mouth, above with scattered spinose warts which become smaller, shorter, and more crowded downwards, ochraceous when dry. Capillitium dense, threads thicker than diameter of spores, flaccid, basal sterile stratum well developed, very cellular; spores olivaceous-brown, smooth, globose, $4\ \mu$ diam. Sometimes subclavate and plicate at the base. Plate XII. figs. 1-3.

From $1\frac{1}{2}-2\frac{1}{2}$ in. high, $\frac{3}{4}$ in. across. On the ground. New Zealand.

35. *L. echinulatum*, B. & Br., Fungi Ceylon, No. 722, Linn. Journ., xiv. p. 80.—Turbinate, passing into a short obconic stem, bristling with rather stout spinose warts, which are largest above. Capillitium continuous with the dense indistinctly cellular sterile base; spores citrin, globose, smooth, $3\ \mu$ diam. (= *L. echinellum*, B. & Br., in Herb. Berk.).

From $1-1\frac{1}{4}$ in. diam. On the ground. Ceylon.

36. *L. pyriforme*, Schaeff. Icon., t. 185.—Pyriform, membranaceous, rather umbonate, dehiscing by a small torn mouth, covered with minute pointed warts, becoming smooth; root of numerous white, long, branching fibres. Threads of capillitium thicker than diameter of spores, branched, continuous with the slightly cellular sterile base forming a columella; spores olive, smooth, globose, $4\ \mu$ diam.—*L. pyriforme*, Price, pl. 15. Schaeff., 185. Sci. Gossip, Dec. 1866. Fr. S. M., 3, 38. Hussey, i. pl. lxx. Cooke, Exs., No. 215. Fuckel, Exs., No. 1260. Grev., t. 504. Cke. Hdbk., 1089. Eng. Flor., 304. Karst. Myc. Fenn., iii. 362. Barla, t. 46, f. 10-11. *Utraria pyriformis*, Quel. Jur. et Vosg., 360. *L. ovoideum*, Bull., t. 435, f. 3. *L. pyriforme*, Vitt. Mon., t. 2, f. 9, p. 196.

Generally in clusters. Variable in form and size, from 1-3 in. high. On decaying trunks or on the ground.

Europe, North America, Venezuela, Cuba, Arctic America, Galapagos, Sikkim Himalayas (4-7000 ft.), Bombay, New Guinea, Japan, Tasmania, New Zealand, Australia.

Var. *excipuliforme* Desm.—Caespitose, subglobose, rufous-umber, rough with very slender warts, with a distinct elongated stem; root of long fibres.—Desmazières, Crypt. France, ser. i., No. 1152.

Differs from type in having a slender stem of equal thickness.

Autumn. France.

37. *L. glabrescens*, Berk. Fl. Tasm., ii. 226.—Subhemispherical,

mouth conical, plicate below, at first covered with slender floccose spines, becoming glabrous; stem short, stout, tinged violet inside. Capillitium dense, continuous with the cellular sterile base, threads firm, about as thick as diameter of spores, often nodulose, branching, axils rounded, tapering; spores dark cinnamon, tinged olive, smooth, globose, often pedicellate, 5–6 μ diam.

Peridium $1\frac{1}{2}$ in. diam. Tasmania, Australia.

38. *L. hiemale*, Bull. Champ., t. 72, figs. B, D, E, and t. 475, fig. E.—Subglobose or broadly turbinate passing into the narrowed base-like stem, flaccid, collapsing, at first covered with prominent pointed warts, becoming smooth, dehiscing by an irregular apical pore, often rooting. Capillitium distinct from the well-developed cellular sterile base, threads firm, variable in thickness, branched, axils rounded; spores olivaceous umber, globose, smooth, 3–4 μ diam.—Vitt. Lycop., 190, t. 2, f. 5; Sacc. Mycotheca Ven., 1103; Sacc. Mycol. Ven., 71; *L. echinatum* Schaeff., t. 186, f. 2; *L. gemmatum*, Schaeff., t. 189, f. 4–5.

In dry grassy places. Summer and autumn. Europe, Algeria.

39. *L. molle*, Pers. Syn., 150.—Turbinate, base broad, abrupt, peridium papyraceous, collapsing, furfuraceous, becoming smooth, dehiscing by a small irregular mouth. Threads of capillitium thicker than diameter of spores, collapsing, sterile base well developed, slightly cellular, marginate, almost distinct from the capillitium; spores ochraceous-olive, globose, smooth, 4 μ diam.

Size of *L. pyriforme*, colour much darker, almost dilute olive, very soft to the touch, root none. Pers.

On the ground in oak woods. Autumn. Germany, France, United States.

40. *L. Curtisii*, Berk. Grev., ii. p. 50.—Subglobose, contracted into a short rooting base, pallid, with dense stout spinose warts, which become smaller downwards. Threads of capillitium twice as thick as diameter of spores, flaccid, sterile stratum large, cellular; spores dirty ochraceous, smooth, globose, 3–4 μ diam.

About $1/3$ in. diam.

Connecticut, Upper and Lower Carolina, Somerset East, Africa.

41. *L. leucotrichum*, D. R. & M., Fl. Alg., 383.—Subglobose, base abruptly narrowed, peridium membranaceous, thin, fragile, everywhere covered at first with soft spinose warts, becoming partly smooth, dehiscing by a lacinate orifice. Capillitium white, at length separating from the cellular base, spores smooth, yellowish olive.

Peridium about 1 in. across. In grassy places. Algeria, France.

42. *L. pedicellatum*, Peck, N.Y. Nat. Hist. Mus. Bot. Report (26th), p. 73.—Peridium globose or depressed-globose, sessile or narrowed below into a stem-like base, whitish or cinereous, becoming dingy or smoky brown with age, echinate with rather dense spines, which are either straight or curved or stellately united, and which at length fall off and leave impressions or obscure reticulations on the surface; capillitium and spores greenish yellow, then dingy olive, columella present; spores smooth, pedicellate, 0.00016–0.00018 in. in diameter, the pedicel three to five times as long (= about 4 μ).—U.S. Sp. Lycop., p. 22. "The pedicellate spores constitute the peculiar feature of this species,"

consequently I presume the species could not be recognized from a specimen that had been collected say thirty years. This species is certainly not synonymous with *L. pulcherrimum* B. & C., as stated by Peck.

From $\frac{2}{3}$ to $1\frac{1}{2}$ in. diam. Ground and decaying wood in woods and bushy places. United States.

43. *L. Bonordeni* Mass.—Peridium umbonate capitate or obconic, contracted into a short stem-like base, covered with ventricose spines, white then umber, dehiscing by a torn umbonate mouth. Capillitium forming a columella; spores globose, smooth olivaceous, minute.—*L. hirtum*, Bon. Bot. Ztg., 1857, p. 632. *L. hirtum* Mart. has priority.

In woods. Europe.

44. *L. Kakavu* (Zipp.), Lev. Ann. Sci. Nat., 1844, p. 220.—Peridium rotundato-depressed, covered with minute granular warts, plicate below and passing into the furfuraceous obconic cellular stem. Capillitium and lobose smooth spores olive-brown.—*Bovista Kakavu* Zipp. (Herb. Lugd. : atav.).

About 1 decimetre high. On the ground. Java.

45. *L. bovista* L., Sp. Pl., 1653.—Peridium spherical or depressed, sessile; cortex thick, fragile and evanescent above, breaking up into polygonal pieces, at first sub-tomentose, then smooth; white, becoming darker. Capillitium compact, continuous with the sterile cellular base; spores dusky olive, globose, smooth, rather variable in size, 5–6 μ diam. In Greville's fig. some of the spores are shown with a pedicel.—*L. bovista*, Vitt. Mon., p. 181. Fr. S. M., iii. 29. Karst. Myc. Fenn., iii. 360. Fr. Sverig. Svamp., lxxii. Bull., 447. Vitt. Lyc., 181. *L. giganteum*, Fl. Dan., mdcccxx. Hussey, i. pl. 26. Pabst, Crypt. Flor., t. 23. Cke. Hdbk., 1083. Eng. Flor., 303. Batsch, Elench., p. 238, t. 39, f. 165. Sow., t. 332, upper fig. Corda, Ic., v. f. 40. *Bovista gigantea*, Nees, Pilze, t. xi. f. 124, C. Grev., 336. *L. maximum*, Schaeff. Ic., 191. *Langermannia gigantea*, Sturm, t. 10. *Globularia gigantea*, Quel. Champ. Jur. et Vosg., 362.

Grows to a large size, sometimes a foot or more in diameter. Grassy places. Summer and autumn.

Europe, North America.

46. *L. Fontanesii*, D. R. & Lev., Fl. Alg., 381, t. 22.—Peridium globose or broadly obovate, passing into a narrow strongly plicate base, whitish becoming reddish ochre, thick and leathery, areolate or broken up into soft elongated warts, fragile and breaking away in patches above; root stout, elongated. Capillitium dense, threads thicker than diameter of spores, rarely branched, soon separating from the dense minutely cellular, purple-brown prominent sterile base; spores ferruginous olive, globose, smooth, often pedicellate, 4 μ diam.—*L. complanatum*, Desf. Fl. Atl., p. 435.

Solitary or gregarious, varying in size from an apple to a child's head. In sterile elevated limestone districts.

Algeria, New Zealand.

47. *L. cælatum*, Bull. Champ., t. 430.—Peridium sessile or stipitate, subglobose or depressed, cortex pale creamy ochre, very thin, minutely furfuraceous, breaking away above in areolæ; inner coat thicker, smooth,

ashy grey. Capillitium ochraceous olive, threads frequently branched, axils rounded, thicker than diameter of spores at thickest parts, tapering, evanescent, sterile basal portion well developed, cellular, dense, free from capillitium; spores dirty olive, spherical, smooth, 5 μ diam., frequently furnished with a hyaline pedicel 2–3 times as long as diameter of spore.—*L. cælatum*, Fr. S. M., iii. 32. Vitt. Lyc., 188. Berk. Outl., t. 20, f. 7. Eng. Flor., 303. Krombh., t. 30, f. 7–10. Harzer, t. lxxiv. Schaeff., t. cxc. Nees, Pilze, t. 10, f. 1. Hussey, ii. pl. 23. Cke. Hdbk., 1084. Barla, pl. 46, f. 4. *L. gemmatum*, Schaeff. Ic., t. 189, figs. 1–3. *L. bovista*, Nees, Pilze, t. 11, f. 125. *Bovista officinarum*, Sturm, t. 1. *Utraria cæolata*, Quel. Champ. Jur. et Vosg., p. 360.

Very variable in form, generally spherico-depressed and sessile or with a short thick stem, or with a thin stem from 1–2 in. long. Peridium from 1–4 in. in diameter.

Common in fields, woods, roadsides, &c. Autumn.

All Europe, North America, Behring's Straits, Falkland Islands, Cuba, Neelgheries, Darjeeling, Kuram Valley, India, Tasmania, New Zealand, Algeria, Australia.

48. *L. favosum* (Rostk.), Bon. Bot. Ztg., 1857.—Broadly turbinate, depressed, contracted into a more or less plicate short stem-like base, upper part of peridium fragile, evanescent, leaving a wide opening with torn edges, lower portion with polygonal depressions, presenting a honey-comb-like appearance. Capillitium compact, threads branched, sterile cellular base well developed; spores smooth, globose, blackish olive.—*Bovista favosa*, Rostk., in Sturm, t. 3. *L. cælatum*, Barla, pl. 46, f. 5. 2–3 in. across. On the ground. Europe.

49. *L. capense*, Cke. & Mass., nov. sp.—Globose, sessile, minutely furfuraceous becoming smooth, plicate below, with a long stout tapering root. Capillitium dense, threads of uniform thickness, equal in diameter to spores, simple, much interlaced and curled, continuous with the compact basal stratum, spores bright ochre tinged citrin, smooth, globose, 4 μ diam. Plate XII. figs. 4 and 5.

About 2 in. diam. On the ground. Cape of Good Hope.

50. *L. depressum*, Bon. Bot. Ztg., 1857, p. 611.—Obconic, obtuse or lens-shaped passing into a thick stem, base often plicato-sulcate, covered with small spinose warts, becoming granular or furfuraceous. Threads of capillitium lax, collapsing, thickness about equal to diameter of spores, sterile base well developed, cellular; spores olivaceous umber, smooth, globose, 3–4 μ diam.—Oudemans's Fungi Neerlandici Exs., No. 118.

About 1 in. high. On the ground. Europe.

51. *L. calvescens*, B. & C., Grev., ii. p. 50.—Subglobose, springing from a short thick rooting base, peridium thin, at first with submentose spinose warts which fall away above, leaving the surface minutely velvety. Threads of capillitium variable in thickness, often contorted, basal stratum cellular, spores dirty dark ochre, globose smooth, 3–4 μ diam.

Connecticut.

52. *L. Cookei*, Mass., in Herb. Kew.—Hemispherical or globose, abruptly contracted into a short thick stem-like base, smoky brown above, white below, minutely areolato-furfuraceous, dehiscing by a small irre-

gular mouth. Capillitium continuous with the well-developed cellular sterile base, threads varying in thickness, simple, firm; spores bright citrin, then olivaceous-umber, globose, smooth, sometimes stipitate, $4\ \mu$ diam.—*L. pusillum*, Cooke, in Science Gossip, Dec. 1886. Plate XIII. figs. 24–26.

From $1\frac{1}{2}$ – $2\frac{1}{3}$ in. across. Gregarious. On the ground. England (Kew Gardens, Norfolk), Albany, U.S., Port Jackson, Australia.

53. *L. rugosum*, B. & C., Cuban Fungi, No. 504, Journ. Linn. Soc., x. p. 345.—Irregularly subglobose or turbinate, peridium thick tomentose, rugoso-plicate below, stem very short, thick, ending in a knob-like root. Capillitium continuous with the ample, convex, compact, sterile stratum, threads equal, width about same as diameter of spores, rarely branched, much curled and intricately woven into a dense felted mass; spores ochraceous, globose, smooth, $4\ \mu$ diam.

2–3 in. in diam. Hard and woody when dry. Sometimes two or three spring from the same root. On the ground. Ceylon, Cuba, Niger Expedition.

54. *L. polymorphum*, Vitt. Mon., 183.—Peridium flaccid, persistent, subglobose or depressed, sessile, or passing into a short stout stem, often more or less plicate below, dehiscing by a small orifice, minutely warted, cinereous. Capillitium continuous with the more or less developed floccose compact sterile basal portion, and forming a slightly elevated columella; spores dark dirty olive, globose, smooth, pedicellate, 3–4 μ diam.—Vitt. Mon., t. 2, f. 8. *L. furfuraceum*, Schaeff., t. 294. *L. cepæforme*, Bull., t. 435, f. 2 (bottom row).

Very variable in size and form; never cup-shaped and open when old. In sterile places. Summer and autumn. Europe, Algeria.

55. *L. ericæum*, Bon. Bot. Ztg., 1857, 628.—Peridium subrotund contracted into a very short plicate base, granulose, always obtuse, dehiscing by an apical lacinate mouth, yellowish brown when mature; spores minute, globose, smooth, olivaceous. Europe.

V. Spores elliptical or subglobose.

56. *L. radiculatum*, D. R. & Mont., Fl. Alg., p. 383.—Globose or obovate, outer coat smooth, breaking away in patches, upper portion eventually evanescent, leaving an irregular large opening, root stout, elongated. Threads of capillitium much and irregularly branched, variable in thickness, tapering, continuous with the well-developed cellular base; spores umber, broadly elliptical, smooth, often pedicellate, $6 \times 4\ \mu$ diam.

In sandy places. Algeria. Size variable, up to about $1\frac{1}{2}$ in. diam.

57. *L. phlebophorum*, B. & Br., Fungi of Ceylon, No. 719, Journ. Linn. Soc., xiv. 79.—Irregularly reniform or subglobose, ochraceous, with raised reticulations, between which are minute mealy warts; stem short, attenuated downwards, and terminating in a few branched white fibres. Threads of capillitium thinner than diameter of spores, equal, sterile base cellular; spores broadly elliptical, smooth, ochraceous, 5×3 – $4\ \mu$ diam.

Amongst leaves. Ceylon.

58. *L. Sinclairi*, Berk., in Herb.—Globose, produced into a short thick rooting base; peridium smooth, almost polished, cortex rufous, broken into adnate patches by growth and showing pale ochre between, base reticulato-plicate, upper portion evanescent, forming a large aperture with torn edge. Capillitium separating from the copious slightly cellular sterile base, threads branched; spores bright olive, smooth, broadly obovate, frequently furnished with a short pedicel, $5 \times 4 \mu$.

On the ground. New Zealand.

59. *L. Gardneri*, Berk., Ceylon Fungi, No. 716, Journ. Linn. Soc., xiv. 79.—Peridium subhemispherical, fulvous, minutely floccose or mealy, plicate below and passing into the stout obconic stem. Capillitium persistent, threads rarely branched, flaccid, flexuous or contorted, sterile base compact; spores pale ochraceous, subglobose, slightly produced at the point attached to the persistent pedicel, smooth, longest diameter 5μ diam.

Peridium 3–5 in. diam. Some of the specimens in Berkeley's herbarium have a stout long root.

In shady woods. Ceylon, Venezuela, South Africa.

Species belonging to Group A, but owing to absence of type specimens and information as to surface of spores, could not be arranged under the sections.

I. Spores purple, lilac, or various shades of brown or umber.

60. *L. laxum*, Bon. Bot. Ztg., 1857, 614.—Peridium capitate constricted into a soft often lacunose stem-like base, cortex woolly, breaking away in woolly warts; spores becoming dusky purple.

Europe.

61. *L. rusticum*, Bon. Bot. Ztg., 1857, 614.—Peridium large, capitate, contracted into a stout stem-like base, at first yellowish grey, bristling with spines, then greyish umber and areolate, at length alutaceous, cracked. Spores dusky.

In pine woods. Europe.

62. *L. clavatum* (Fr.), Bon. Bot. Ztg., 1857.—Clavate or elongatopyriform, peridium papyraceous, tough, brownish, dehiscing by a large irregular opening. Capillitium compact, with the spores brown, sterile stem-like base ample.

Bovista clavata, Fr. Syst. Myc., iii. 23.

On the ground. Iceland. 4 in. high by 2 in. wide above.

63. *L. pistilliforme*, Bon. Bot. Ztg., 1857, 613.—Peridium pistilliform, capitate, yellow-brown, stem long, elastic, bright brown inside. Capillitium and subpedicellate spores brown.

Europe.

64. *L. alveolatum*, Lev. Ann. Sci. Nat., 1846, p. 163.—Peridium subglobose, membranaceous, passing into a short obconic stem-like base, covered with small angular micaceous warts, broken up in an areolato-sinuous manner. Capillitium and spores fulvous.

From 4–5 cm. diam. On the ground. Neilgherries, India.

65. *L. aculeatum* (Rostk.), Bon. Bot. Ztg., 1857.—Spherico-depressed, obtuse, plicate below, densely covered with long spinose warts,

very fragile above, breaking away in patches, leaving a wide irregular opening, stem stout, cellular. Capillitium and spores umber, evanescent.—*Langermannia aculeata*, Rostk., in Sturm, t. 13.

About $2\frac{1}{2}$ in. high, 1 in. broad. Europe.

66. *L. areolatum*, Rostk., in Sturm, t. 5.—Spherico-depressed, tapering into the stem-like base; peridium membranaceous, persistent, cortex broken up into areolæ, dehiscing by a small toothed umbonate mouth, stem cellular. Flocci forming a columella, spores brown.

About 2 in. high, $1\frac{1}{2}$ in. broad. Europe.

67. *L. flavescens* (Rostk.), Bon. Bot. Ztg., 1857.—Pyriform with a stout cellular stem-like base, very obtuse, yellowish, very brittle above where it is covered with minute scale-like warts, breaking away in areolæ and leaving a wide opening. Capillitium evanescent, with the spores brown.—*Langermannia flavescens*, Rostk., in Sturm, t. 14. *L. truncatum*, Batsch, t. 42, f. 230, *a*, *b*? *L. defossum*, Batsch, t. 42, f. 229, *a*?

About 2 in. high, $1\frac{1}{2}$ in. broad above. On the ground in pine woods. Europe.

68. *L. punctatum* (Rostk.), Bon. Bot. Ztg., 1857.—Peridium depresso-globose, contracted into a stout, equal, lacunose, cellular stem, yellowish, minutely punctate, above fragile, breaking away in areolæ and leaving a wide cup-like opening. Capillitium evanescent, with the spores brown.—*Langermannia punctata*, Rostk., in Sturm, t. 12.

Europe.

69. *L. pertusum*, Sow. Fungi, t. 412, f. 2.—Subglobose or slightly contracted into a short thick stem-like base. Peridium membranaceous, evanescent above, at first covered with minute furfuraceous warts, at length smooth and becoming perforated by numerous irregular holes. Capillitium pallid.—Berk. Ann. Nat. Hist., vii. 454.

About 1 in. across.

"It is remarkable for bursting extremely raggedly, and having a number of holes in it, at first sight looking very much like insect holes; it is also generally so weak, that it becomes almost pendant by the root."—Sow.

Among moss on the stem of a beech. England (Berks).

The Rev. M. J. Berkeley, F.R.S., has described a plant from Arctic America which he considers to be identical with the present species, which has not been recognized in England since Sowerby's time. "About the size of a hazel nut. Precisely the plant of Sowerby, except that his species is figured with a spurious stem. It is clearly no *Rhizogon* as asserted by Fries."—M. J. B.

2. Spores olive or various shades of yellow.

70. *L. suberosum* (Fr.), Bon. Bot. Ztg., 1857.—Depressoglobose contracted into a stout cellular stem-like base, peridium very thick, corky, bark breaking away, dehiscing by an irregular large opening. Capillitium compact, and with the spores obscure alive.—*Bovista suberosa*, Fr. Syst. Myc., iii. 26. Rostk., in Sturm, t. 2.

About 2 in. across. Europe.

1887.

3 B

71. *L. candidum* (Rostk.), Bon. Bot. Ztg., 1857.—White. Spherico-depressed, obtuse, above very fragile and breaking away, leaving a very wide irregular opening. Capillitium evanescent, with the spores yellow, sterile base well developed, continued into a stout twisted tapering root.—*Langermannia candida*, Rostk., in Sturm, t. 11.

About $1\frac{1}{2}$ in. wide by $\frac{3}{4}$ in. high. Europe.

72. *L. lætum*, Berk. Hook. Journ., 1843, p. 419.—Peridium subglobose or lenticular, contracted into a stout stem-like cellular base, at first covered with pyramidal warts, subcoriaceous, becoming rimoso-areolate and breaking away above, leaving a cup-like opening. Spores at first yellow, becoming smoky yellow.

Peridium about $1\frac{1}{2}$ in. high, $1\frac{1}{4}$ in. broad, pale; stem $\frac{3}{4}$ in. high, 1 in. thick, reddish brown, furfuraceous. On the ground. Cape of Good Hope.

B. *Sterile basal stratum, rudimentary or obsolete.*

I. *Spores globose, rough, purple, lilac, or various shades of brown.*

73. *L. tephrospermum*, B. & C., Cuban Fungi, No. 509, Journ. Linn. Soc., x. 345.—Sessile, globose, peridium thick, leathery, whitish, with minute tomentose warts; root consisting of a dense mass of white fibres. Capillitium umber, threads firm, rarely branching, wider than diameter of spores at thickest part, tapering, sterile stratum obsolete; spores dark brown, globose, minutely warted, $3-4\ \mu$.

From $\frac{1}{2}$ –1 in. in diameter. On the ground. Cuba.

74. *L. velutinum*, B. & C., Herb. Berk.—Subglobose or broadly obovate, sessile, peridium thick, persistent, bright brown, velvety; root of numerous dark fibres. Capillitium dense, threads about equal in thickness to diameter of spores, sterile base obsolete; spores ochre with a tinge of lilac, globose, very minutely warted, $4\ \mu$ diam.

About 1 in. across. On the ground. Venezuela.

75. *L. delicatum*, Berk. Hook. Journ., vi. 172 (1854).—Globose, membranaceous, thickly covered with minute granules, dehiscing by a small irregular mouth. Threads of capillitium varying in thickness, often contorted, tapering, frequently branched, axils acute, sterile base small; spores brownish purple, globose, echinulate, often with a long pedicle, $6\ \mu$ diam.

From 1–2 in. across. On the ground. Khasia Mountains, N.W. Himalayas.

76. *L. epixylon*, B. & C., Cuban Fungi, No. 508, &c., Journ. Linn. Soc., x. 345.—Sessile, hemispherical, rufous densely covered with minute adnate granules. Threads of capillitium flexuous, branched, very delicate, sterile portion obsolete; spores umber, globose, strongly echinulate, $6\ \mu$ diam.

Peridium $\frac{1}{2}$ –1 in. diam. On rotten wood. Cuba.

II. *Spores globose, rough, brownish olive, olive, or various shades of yellow.*

77. *L. fuliginum*, B. & C., Cuban Fungi, No. 506, Journ. Linn. Soc., x. 345.—Peridium subglobose or obovate, fuliginous, becoming

paler towards the base, minutely tomentose, dehiscing by a small dentate mouth. Threads of capillitium flaccid, sterile stratum obsolete; spores pale reddish ochre, globose, echinulate, $4\ \mu$ diam.

Peridium 1 in. or more in diam. On rotten trunks. Cuba.

78. *L. Vittadini* Mass., nov. sp.—Globose, sessile; peridium rigid, woolly, mouth small, irregular, rufous when dry. Capillitium dense, threads firm, flexuous, about equal in thickness to diameter of spores, sterile base obsolete. Spores brownish olive, globose, strongly echinulate, $4\ \mu$ diam.

Sent by Vittadini to the Rev. M. J. Berkeley as *L. defossum*, along with another specimen which was the true *L. defossum*, as described by Vittadini. A striking illustration of the worthlessness of external characters alone in the discrimination of species.

About $2/3$ in. across. Italy.

79. *L. subincarnatum*, Peck, N.Y. Nat. Hist. Mus. Bot. Report (24th).—Peridium globose, rarely either depressed or obovate, gregarious or cæspitose, sessile, with but little cellular tissue at the base, covered with minute nearly uniform pyramidal or subspinulose at length deciduous warts, pinkish brown, the denuded peridium whitish or cinereous, minutely reticulate-pitted; capillitium and spores greenish yellow, then dingy, olivaceous, columella present; spores minutely rough, $0\cdot00016$ – $0\cdot00018$ in. in diameter (= about 4 – $5\ \mu$).

From $1/2$ to 1 in. broad. Sometimes has white fibrous roots like *L. pyriforme*.

Prostrate trunks, old stumps, &c., in woods. Common. Aug.–Oct. United States.

III. Spores globose, smooth, purple, lilac, or various shades of brown.

80. *L. pusio*, B. & C., Cuban Fungi, No. 503, Journ. Linn. Soc., x. 344.—Globose, smooth, thick, corrugated when dry, mycelium forming a dense fibrous rooting mass. Capillitium dense, threads often two to three times thicker than diameter of spores, firm, tapering, sterile base obsolete; spores purple-umber, globose, smooth, from 2 – $3\ \mu$ diam.

About $1/3$ in. diam. On rotten wood, into which the mycelium penetrates deeply. Cuba.

81. *L. Astrocaryi*, Berk. & Cke., Brazil Fungi, Journ. Linn. Soc., xv. 393.—Sessile, globose, attached by a broad base, brown, minutely granulate, dehiscing by a small subrotund mouth. Threads of capillitium slender, collapsing, sterile base almost obsolete; spores dirty ochre, eventually assuming a lilac tinge, smooth, globose, $3\ \mu$ diam.

From $1/4$ – $1/2$ in. across. On petioles of *Astrocaryum*. Brazil.

82. *L. Emodense*, Berk., in Hook. Journ., vi. 172 (1854).—Ovate, passing into a very short stem, peridium minutely furfuraceo-squamulose, rufous, dehiscing by a large irregularly torn mouth; root of long white branched fibres. Threads of capillitium branched, axils acute, varying in thickness, flexuous, basal barren stratum obsolete; spores brownish umber, globose, smooth, $4\ \mu$ diam.

About 1 in. high, $3/4$ in. thick. On the ground, sometimes growing in clusters. Sikkim Himalayas (9–10,000 ft.), E. Nepaul (9000 ft.).

83. *L. australe*, Berk. Fl. Tasm., ii. 266.—Sessile, globoso-depressed, densely covered with small pointed warts, which are smaller and granular towards the base, eventually disappearing and leaving the surface smooth and shining, dehiscing by a small raised mouth, root long, tapering. Capillitium very dense, persistent, threads very variable in thickness, branched, axils rather acute, scanty sterile base cellular; spores umber, globose, smooth, generally furnished with a long pedicel, $5\ \mu$ diam.

1 in. or more in diameter. On the ground. Melbourne, Tasmania.

84. *L. rubellum*, B. & C., Cuban Fungi, No. 507, Journ. Linn. Soc., x. 345.—Sessile, obovate or subglobose, rufous, rough with minute spinose warts, becoming smooth, dehiscing by a small apical opening, often with white fibrous mycelium. Capillitium dense, threads generally thicker than diameter of spores, much branched, axils rounded, sterile base scanty, compact; spores umber, globose, smooth, $5\ \mu$ diam.

From $1\frac{1}{2}$ – $2\frac{2}{3}$ in. diam. On rotten wood. Cuba.

85. *L. Brasiliense*, Fr. Syst. Myc., iii. 40.—Globose, sometimes with a short stem, brownish when dry, peridium membranaceous, flaccid, persistent, with minute adnate warts, mouth small, obtuse, root white, branching. Threads of capillitium equal, about same thickness as diameter of spores, rarely branching, lax, sterile base almost obsolete; spores brown, globose, smooth, 3 – $4\ \mu$ diam.

From $1\frac{1}{2}$ – $2\frac{2}{3}$ in. across. Cæspitose, on trunks. Brazil, Pegu.

86. *L. Wrightii*, B. & C., Grev., ii. p. 50.—Sessile, globose, papyraceous, at first covered with minute spinose warts, becoming smooth, dehiscing by a minute silky orifice. Threads of capillitium firm, sparsely branched, axils acute, often contorted towards the lips, sterile base obsolete; spores umber, globose, smooth, $4\ \mu$ diam.—*L. separans* Peck, N.Y. Nat. Hist. Mus. Bot. Report (26th).

$\frac{3}{4}$ in. diam. In Berkeley's description the spores are said to be *clay-coloured*. Connecticut, New Jersey.

IV. Spores globose, smooth, brownish olive, olive, or various shades of yellow.

87. *L. stellatum*, Cke. & Mass., Grev., March 1887.—Sessile, subglobose; peridium thin, flaccid, at first covered with stout stellate spinose warts, which break away in patches, leaving a smooth surface, mouth minute, torn. Threads of capillitium firm, rarely branched, equal in thickness to diameter of spores, continuous with the scanty floccose sterile base; spores dirty olive, smooth, globose, $5\ \mu$ diam. Plate XII. figs. 10–12.

About $1\frac{1}{2}$ in. across. On the ground, in clusters of two or three. Israelite Bay, S.W. Australia.

88. *L. substellatum*, B. & C., in Herb. Berk.—Globose, sessile, whitish, covered with delicate flocculose spines, becoming smaller downwards. Threads of capillitium collapsing, simple, sterile base obsolete, spores ochraceous, globose, smooth, $3\ \mu$ diam.

From $1\frac{1}{4}$ – $1\frac{1}{2}$ in. across. On rotten wood. Cuba.

89. *L. cruciatum*, Rostk., in Sturm, t. 8.—Subpyriform or subglobose, bristling with stout spinose warts which are often split up at

the base in a cruciate manner, breaking away in patches and leaving a brown minutely velvety surface. Threads of capillitium thicker than diameter of spores, flaccid, often contorted, tapering, barren basal stratum almost obsolete; spores ochraceous-cinnamon, smooth, globose, $4\ \mu$ diam.—*Utraria cruciata*, Quel. Jur. et Vosg., 359.

From $\frac{2}{3}$ to 1 in. high. Sometimes rooting. Europe. Rhode Island.

90. *L. grumosum*, B. & C., Herb. Berk.—Globose, sessile, plicate below and passing abruptly into a slender root, peridium thin, tough, almost smooth. Capillitium very dense, continuous with the compact scanty sterile base, threads about equal in thickness to diameter of spores, much interlaced; spores ochraceous-olive, globose, smooth, $4\ \mu$ diam.

About $1\frac{1}{2}$ in. across. On the ground. Cuba.

91. *L. muricatum*, Bon. Bot. Ztg., 1857, 612.—Obconic or lentiform contracted into a very short furrowed base, at first white and above covered with triangulose spinose warts, then umbonate, becoming smooth and brown. Threads of capillitium about thickness of diameter of spores, flexuous, tapering, sterile base almost obsolete; spores umber, tinged olive, smooth, globose, often with a long pedicel, $5\ \mu$ diam.—Fueckel, Fungi Rhenani, Exs., No. 1257.

From 1–2 in. broad. In pine woods and sandy pastures. Germany.

92. *L. turbinatum*, B. & C., Cuban Fungi, No. 510, Journ. Linn. Soc., x. 345.—Turbinate, passing into a long tapering root, glabrous, reddish umber. Capillitium dense, threads about equal in thickness to diameter of spores, flexuous; scanty sterile base compact; spores dirty cinnamon, globose, smooth, $4\ \mu$ diam.

Peridium about $1\frac{1}{2}$ in. diam. On rotten wood in dense forests. Cuba.

93. *L. microspermum*, Berk. Hook. Journ., vi. p. 172 (1854).—Subglobose, flaccid, persistent, at first with small acute warts, becoming smooth, dehiscing by a small round mouth, root usually elongated. Threads of capillitium much wider than diameter of spores, firm, branched, axils rounded, tapering flexuous towards the tips; sterile base obsolete; spores brownish olive, globose, smooth, $2\text{--}3\ \mu$ diam.

Peridium $1\frac{1}{2}$ –1 in. across. On the ground. Darjeeling, India, New Zealand.

94. *L. citrinum*, B. & Br., Ceylon Fungi, No. 724, Journ. Linn. Soc., xiv. 80.—Broadly elliptic, sessile, pale citrin minutely warted, dehiscing by a small apical opening, root long cord-like. Threads of capillitium of varying thickness, tapering, frequently branched, sterile base cellular, scanty; spores pale olive, globose, smooth, often pedicellate, $5\ \mu$ diam.

From $\frac{1}{2}$ – $\frac{2}{3}$ in. diam. On the ground. Ceylon.

95. *L. flavum*, Mass., nov. sp.—Globose, yellowish olive, fibrillose or minutely furfuraceous, dehiscing by a small apical mouth. Threads of capillitium very variable in thickness with slender scattered spines, rarely branched, sterile base obsolete, spores dirty lemon yellow, globose, smooth, $5\ \mu$ diam. Plate XIII. figs. 27–29.

About 1 in. across. On the ground. Cape of Good Hope.

96. *L. dermoxanthum*, Vitt. Mon., p. 177.—Peridium very thin and flaccid, persistent, sessile, irregularly globose, base more or less

plicate, root rather long, slender; minutely furfuraceous, dehiscing by a minute opening, bright yellow, becoming brownish. Threads of capillitium very slender, lax; sterile portion obsolete; spores ochraceous-olive, globose, smooth, 3-4 μ diam.—Vitt., t. 2, f. 2. Mich. Gen., t. 97, f. 3.

Variable in size, from 1/2-1½ in. In grassy places. July-Oct. Italy, Algeria.

97. *L. defossum*, Vitt. Mon., p. 177, t. 2, f. 2.—Peridium thick, rigid, globose, sessile, floccose, dehiscing by a small aperture. Threads of capillitium thicker than diameter of spores, branched, tapering, basal sterile stratum obsolete; spores ochraceous olive, becoming almost umber, globose, smooth, with a short pedicel, 5 μ diam.

From 1/2-3/4 in. across. In sandy places. At first subterranean, emerging from the ground when mature; the floccose cortex generally carries along with it a quantity of sand which becomes agglutinated by mucus from the inner diffuent wall of the peridium. Italy.

98. *L. conspurcatum*, B. & Br., Ceylon Fungi, No. 723, Linn. Journ., xiv. p. 80.—Globose, sessile, peridium thin, minutely warted, here and there cracked into areolæ, base short, rooting. Capillitium floccose, continuous with the minute sterile base; spores olive, globose, smooth, often pedicellate, 4 μ diam.

Scarcely 1 in. in diameter. On the ground. Ceylon.

99. *L. reticulatum*, Berk., in Herb.—Peridium globose or broadly obovate, with slightly raised reticulations which eventually disappear, leaving a polished surface. Capillitium persistent, threads slender, flaccid, barren stratum scanty, cellular; spores pale yellowish grey, globose, smooth, 4 μ diam.

About 3/4 in. diam. Australia, New Zealand.

100. *L. cepæforme*, Bull., t. 403, f. 2 (upper row).—Sessile, subglobose, peridium papyraceous, persistent, cortex white, minutely furfuraceous, breaking away in patches, dehiscing by a minute torn mouth, root long, cord-like. Threads of capillitium much branched, thicker than diameter of spores, much branched, axils rounded, sterile base obsolete, spores bright citrin, smooth, globose, often with a short thick pedicel, 4 μ diam.—*L. pratense*, Pers. Syn. Fung., p. 143. *Globularia furfuracea*, Quel. Champ. Jur. et Vosg., 361. Vittadini's figure of *L. plumbeum*, t. 33, f. 1, Fung. Mang., very much resembles Bulliard's figure, but in the former the spores are said to be "fusco-purpurea."

About 1 in. across. Europe.

101. *L. Cubense*, Berk., in Herb.—Subglobose, peridium thick, tomentose, root a dense mass of white fibres. Threads of capillitium flaccid, simple, barren stratum almost obsolete, spores ochraceous, globose, smooth, 3 μ diam.

From 1/2-1 in. across. Amongst decayed leaves. Cuba.

102. *L. leprosum*, B. & Rav., Fungi Car. Exs., No. 14.—Sessile, globose, whitish, with scurfy granules, mouth small. Capillitium continuous with the minute sterile base, threads about three times as thick as diameter of spores, flaccid, not branched; spores yellowish olive, globose, smooth, often shortly pedicellate, 3 μ diam.

Scarcely $1/2$ in. across. Amongst moss on trunks. S. Carolina, Georgia, Florida.

103. *L. tephrum*, Berk., in Herb.—Sessile, globose, peridium thick and rigid, brown, minutely velvety. Capillitium scanty, threads delicate, sterile base obsolete; spores pale ochraceous olive, globose, smooth, $3-4 \mu$ diam.

From $1/2-2/3$ in. across, sometimes with a branched rooting base. Brisbane.

104. *L. scrobiculatum*, Ces. Myc. Born., 12.—Subspherical, bay coloured, scrobiculate. Sterile base inconspicuous, spores globose, smooth, yellowish.

Size and general appearance of *Lycogalus epidendrum* (Ces.). On decayed grass stems. Sarawak.

105. *L. albinum*, Cke., in Herb.—Sessile, globose, white, minutely mealy. Threads of capillitium scanty, slender, flaccid, sterile base almost obsolete; spores clay colour, smooth, globose, 3μ diam.

Peridium $1/2-1/3$ in. across. On rotten wood and branches. Brazil.

106. *L. pusillum* Fr.—Peridium subglobose, sometimes slightly attenuated below, flaccid, persistent, with minute adpressed scurfy squamules, becoming smooth, dehiscing by a minute irregular apical pore, pale olivaceous ochre, furnished with a cord-like root. Capillitium dense, threads much branched, axils well rounded, lax, flexuous, sterile base obsolete; spores olivaceous ochre, globose, smooth, 4μ diam.—*L. pusillum*, Fr. S. M., iii. 33. Cke. Hdbk., 1086. Eng. Fl., 304 (in part). Karst. Myc. Fenn., iii. p. 360. Batsch, Elen., f. 228, var. Bolt., t. 117, f. C. Schaeff. Ic., t. 294. Bull., t. 435, f. 2. Fekl. Exs., No. 1261. *Globularia pusilla*, Quel. Champ. Jur. et Vosg., ii. t. 3, f. 7.

From $1/4-2/3$ in. diam. Europe, North America, Bonin Islands, Lower Pegu, Hong Kong, Whampoa, East Nepaul, Rio Janeiro, Ceylon, New Zealand, Melbourne, Somerset East (Africa), King George's Sound.

107. *L. calyptræforme*, Berk. Grev., ii. p. 50.—Ovate, apex papillate, furfuraceous or with minute mealy warts, base rooting. Threads of capillitium much thicker than diameter of spores, sterile stratum obsolete; spores dirty ochraceous, smooth, globose, 3μ diam. Plate XIII. figs. 16 and 17.

About $1/3$ in. across. Upper Carolina.

V. Spores elliptical or subglobose.

108. *L. oblongisporum*, B. & C., Cuban Fungi, No. 505, Journ. Linn. Soc., x. 345.—Sessile, subglobose, pale brown, with minute persistent warts. Capillitium continuous with the minute sterile base, threads about equal to short diameter of spores, branched, axils acute; spores brown, smooth, elliptic-oblong, $6 \times 3 \mu$ diam. Plate XII. figs. 8 and 9.

Up to 1 in. diam. Amongst leaves. Cuba.

109. *L. Hongkongense*, B. & C., Proc. Amer. Acad., 1859, 124.—Pyriform or elliptical, with minute warts above, becoming smooth, dehiscing by an irregular apical aperture; rooting. Capillitium reddish ochre, sterile base obsolete; spores subferruginous, elliptic, smooth, pedicellate, $4-2 \mu$ diam.

About $2/3$ in. high. On the ground. Hong Kong.

110. *L. plicatum*, B. & C., Proc. Amer. Acad., 1859, 125.—Subrotund or depressed, white becoming pale brown, cortex with minute warts, splitting away above, plicate below and produced into a very short stem. Capillitium continuous with the scanty sterile base; spores broadly elliptic, smooth, often shortly pedicellate.

From 1/2–2/3 in. diam. On the ground. Japan.

111. *L. gauterioides*, B. & Br., Fungi Ceylon, No. 718, Journ. Linn. Soc., xiv. p. 79.—Irregular, suborbicular, leathery, citrin. minutely furfuraceous, rugoso-lacunose especially below, stem very short. Threads of capillitium much branched, axils rounded, sterile base scanty; spores olive, smooth, broadly elliptic. $5 \times 4 \mu$ diam.

A little over 1 in. diam. On scorched ground. Ceylon.

112. *L. coloratum*, Peck, N.Y. Nat. Hist. Mus. Bot. Report (29th)—Peridium globose or obovate, sessile, radicate, yellow or reddish-yellow, brownish when old, slightly roughened with minute granular or furfuraceous persistent warts; capillitium and spores at first pale, inclining to sulphur colour, then dingy olive; spores subglobose, smooth, about 0.00016 in. diam. (= about 4μ).—U.S. Sp. Lycop., pp. 29–30.

“There is a slight depression in one side of the spore, so that when viewed in a particular direction, it appears flattened or depressed on one side, although if viewed in a different direction it may appear globose.”

Less than 1 in. across. Ground in thin woods and bushy places. Rare. July and August. United States.

113. *L. xanthospermum*, Berk. Hook. Journ., vi. p. 172 (1854).—Globose or broadly obovate, peridium thin, persistent, yellowish with minute brown specks of outer peridium remaining. Threads of capillitium firm, simple, about equal in thickness to diameter of spores, continuous with the scanty cellular base; spores dark yellow tinged olive, smooth, subglobose, generally pedicellate, about 5μ diam.

About 1 in. diam. Not furfuraceous. On the ground. Khasia, India.

Species belonging to group B, but owing to absence of type specimens and information as to surface of spores, could not be arranged under the sections.

114. *L. tomentosum*, Vitt. Mon. Lyc., p. 179.—Peridium very thin, persistent, chestnut brown, covered with evanescent tomentum, dehiscing by a minute mouth. Sterile base none, spores olive-brown.—Vitt., t. 1, f. 10.

In dry pastures, semi-immersed. Aug.–Sept. Italy.

115. *L. purpurascens*, B. & C., Proc. Amer. Acad., 1859, 124.—Small, subglobose, contracted into a sub-aculeate base, purplish then brown, innato-squamulose above. Sterile stratum obsolete, spores yellowish olive.

On decayed trunks. Bonin Islands.

116. *L. mundula*, Kalch. Grev., ix. p. 3 (1880).—Peridium floccose, becoming smooth, white, size of a hazel-nut. Spores and capillitium carneo-rufous, 0.004 mm. diam.

Similar to *L. pusillum*, but colour of spores different. Australia.

The following species could not be arranged under Groups A or B, owing to imperfect descriptions, and absence of type specimens:—

1. Spores purple, lilac, or various shades of umber or brown.

117. *L. asperillum*, Welw. & Curr., Fung. Angol. Trans. Linn. Soc., xxvi. p. 289, t. 20, f. 14.—Subglobose, 1 in. or more high, peridium cinnamon, papyraceous, when young bristling with spines, becoming smooth, capillitium reddish; spores same colour, globose, minutely echinulate, $4\ \mu$ diam.

Amongst bushes in sandy places. West Africa.

118. *L. Welwitschii* Mass.—Peridium globose or subturbinate, horny, fragile, blackish purple, clothed with dense rufous tomentum. Capillitium brown, spores brown, very minutely echinulate, about $3\ \mu$ diam.—*L. tomentosum*, Welw. & Curr., Fungi Angol., Linn. Trans., xxvi. p. 289, t. 19, f. 7–8 (1868). There is a *L. tomentosum* Vitt. of prior date.

On damp ground, amongst rotten leaves. Golungo, West Africa.

119. *L. Novæ Zealandiæ*, Lev. Ann. Sci. Nat., 1846, p. 164.—Peridium globose, sessile, papyraceous, evanescent above and opening by a very large mouth, at first covered with minute white shining warts, lacunoso-plicate below, flesh and smooth spores violet.

From 5–7 cm. diam. On the ground. New Zealand.

120. *L. cæspitosum*, Welw. & Curr., Fung. Angol., Trans. Linn. Soc., xxvi. pp. 289–90, t. 20, f. 1–2.—Subglobose; $1/4$ – $1\frac{1}{2}$ in. high, $1/4$ – $1\frac{1}{2}$ in. across, rooting, white when growing, yellowish when dry, papyraceous, at first warted then almost naked; capillitium argillaceous lilac, yellowish under the Microscope; spores same colour, globose, smooth, 5 – $6\ \mu$ diam.

In grassy places. West Africa; Somerset East, Africa.

121. *L. serotinum*, Bon. Bot. Ztg., 1857, 631.—Globose, always obtuse, contracted into a short rooting base, above with rufous-brown spines, yellowish-white becoming ochraceous brown, dehiscing by an entire mouth. Spores brownish ochre, minute, globose, smooth.

Near trunks and roots. Europe.

122. *L. fuscum*, Bon. Bot. Ztg., 1857, 626.—Small, pyriform or obconic, at first with white spines of various sizes, becoming yellowish and granuloso-floccose, umbonate, at length brown, mouth entire or laciniate. Spores yellow-brown, minute, smooth.

Europe.

123. *L. cretaceum*, Berk. Linn. Journ., xvii. p. 15.—Sessile, globoso-depressed, pale fulvous, scabroso-pulveraceous, above broken up into rigid chalky pyramidal areolæ; mycelium creeping, white. Capillitium brown, threads coarse, irregular, spores $0\cdot005$ – $0\cdot007$ mm.

Bellot Island (Arct. Exp.).

124. *L. gossypinum*, Bull. Champ., p. 147, pl. 435, f. 1.—Minute, subturbinate; peridium flaccid, minutely woolly, spores brown.

From 2–3 lines across. Peridium white, becoming brownish. Gregarious on rotten wood. France.

2. Spores tinged with olive or various shades of yellow.

125. *L. foetidum*, Bon. Bot. Ztg., 1857, 629.—Shape variable, often deformed, brown or bay, bristling with simple and angular spinose warts which fall away leaving reticulate markings, becoming subumbonate and dehiscing by a terminal mouth. Spores small, globose, smooth, rufous-olive or greenish brown.

Smell like *Scleroderma vulgare*. In woods. Europe.

126. *L. sculptum*, Harkn. Bull. Calif. Acad. Sc., Feb. 1885, p. 160, pl. 1.—Subglobose or obovate, 8–15 cm. in diam., pure white. Outer peridium very thick, forming pyramidal masses 2–4 cm. in breadth and $1\frac{1}{2}$ –3 in. in height, which are longitudinally grooved by many parallel lines; in age dividing vertically into several segments which usually remain attached at the apex: spore mass bright yellow, becoming cinereous; flocci yellow, 6–10 μ ; spores smooth, pale, 5–8 μ .

Sierra Nevada, 6–8000 ft.

127. *L. Gunnii*, Berk. Fl. Tasm., ii. 265.—Sessile, subglobose, with very minute stellate warts. Columella short, spores bright olive, globose, with long pedicels, $1/6000$ in. diam.

Olive, 1–2 in. diam. In pastures. Tasmania, Australia.

128. *L. golungense*, Welw. & Curr., Fung. Angol., Trans. Linn. Soc., xxvi. p. 289, t. 20, f. 13.—Peridium globose or obovate, clothed with delicate fastigate tomentum, springing from a dense mass of mycelium; capillitium and spores unknown.

At the base of rotten trunks. West Africa.

129. *L. furfuraceum*, Batsch, Elen., p. 145.—“Sessile, globose, furfuraceo-squamoso.—Mich., 97, f. 6.”

Europe.

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SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Theory of Sex and Reproduction.‡—In a paper entitled "Theory of Growth, Reproduction, Sex, and Heredity," Mr. P. Geddes seeks to interpret these in terms of their "fundamental secret, that of constructive and destructive metabolism—anabolism and katabolism."

(1) Following Spencer, *growth* is more intimately defined as the preponderance of an anabolic tendency, rhythm or diathesis, while the limit of growth corresponds to the maximum of katabolic preponderance consistent with life, in other words to the climax of the katabolic diathesis.

(2) *Reproduction* in all its forms is similarly treated. Like continuous cell-division, asexual reproduction occurs when waste or katabolic processes are in the ascendant. The phylogenetic evolution of sexual dimorphism, which is briefly summarized, is interpretable as the gradual differentiation of comparatively sluggish, more nutritive, preponderatingly anabolic (female) cells, and more mobile, finally more exhausted, and emphatically katabolic (male) elements. The evolution of *fertilization* by gradual stages from the almost mechanical flowing together of exhausted cells (or plasmodia) is sketched. By reference to aphides, plants, &c., the author illustrates how, just as asexual reproduction occurs at the limit of growth, a check to the asexual process involves the appearance of the sexual, which is thus only associated with katabolic preponderance. In many fungi it may be seen that the greater the anabolism the less sexuality. Some beautiful and suggestive illustrations are given of the relation of sexual to asexual reproduction. *Alternation of generations* is interpreted as a rhythm between a relatively anabolic and katabolic preponderance, and other phenomena of reproduction are similarly rationalized.

(3) *Nature of Sex*.—Proceeding first on inductive lines, the author shows (a) that the male and female elements exhibit in fundamental and concentrated expression the katabolic and anabolic antithesis; (b) that the same

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Proc. R. Soc. Edin., 1886, pp. 911-31.

is well illustrated in the incipiently dimorphic reproductive elements of *Volvox* and the like; (*c*) that male tissues, like those of an anther, exhibit signs of predominant katabolism; (*d*) that the female organs of *Chara* or *Nitella* correspond in position to the vegetative anabolic internodal cells, and the male organs to the smaller, dividing nodal cells; (*e*) that over a wide area the sum total of female characteristics—more vegetative, nutritive, conservative, &c.—are interpretable as anabolic, and that the average male characteristics—smaller size, more active habit, higher temperature, shorter life, &c.—are similarly the expression of a predominant katabolic diathesis; and (*f*) that in the conditions affecting the determination of sex, influences inducing katabolism tend to result in production of males, as those favouring anabolism similarly go to increase the probability of females.

And then deductively, Mr. Geddes proceeds to apply this notion of anabolic "femaleness" and katabolic "maleness" to the reproductive elements in their various forms and phenomena, to the processes of maturation in oogenesis and spermatogenesis, to the physiology of fertilization, to the tissues, organs, forms, and habits of the two sexes.

(4) In regard to *heredity*, the author chiefly emphasizes the now familiar notion of the direct continuity between the rudimentary reproductive organs of the embryo and the parent ovum. The protoplasmic continuity is in itself a partial explanation of the continuity in history. For "if the reproductive elements start with a specific protoplasm continuous with that of the combined mother ovum and fertilizing sperm—that is, with a concentrated accumulation of characteristic anastates and katastates, the simple fact that the products of protoplasmic change must be fixed, definite, and continuous, as in all chemical processes, gives us at once a protoplasmic basis from which to explain the constant and necessary symmetry of segmentation and development." While, if superficial acquired characters be indeed inherited, "it must not be forgotten that all the organs do to a certain extent share mutually in nutriment and waste products, and that thus, besides the characteristic specific protoplasm acquired through direct continuity, both germinal cells and developing embryo may accumulate a proportion of characteristic anastates and katastates, acquired, as it were, pangenetically" from the organs of the body.

(5) The ingenious and suggestive paper closes with an application of the above conceptions to the genealogical tree as a whole. In this the author seeks to show how we are to "look forward to the solution of the problem of ætiology in deeper terms than those of 'natural selection' alone, as illustrations, namely, of a continuous rhythm of anabolic and katabolic change."

History and Theory of Spermatogenesis.*—Messrs. P. Geddes and J. Arthur Thomson have given (1) an historical account of the progress of research in regard to the process of spermatogenesis, and have sought (2) to collate in tabular form the all too-confusing nomenclature of the subject, for which a symbolic notation is suggested. (3) After noting the various homologies between oogenesis and spermatogenesis, the authors seek to unify and rationalize the various modes of spermatogenesis described by different authorities, by comparing them in detail with the various forms of segmentation. This suggestion has also been made, though not followed up, by Herrmann (1881), and has been hinted at in the nomenclature of Balfour and others. The aim of the paper is to suggest that the multitudinous details of spermatogenesis can be morphologically rationalized by collating them with the details of ovum segmentation. A bibliography and explanatory plate are added.

* Proc. R. Soc. Edin., 1886, pp. 803–23 (1 pl.).

Spermatogenesis of Mammalia.*—Herr C. Benda communicates a full report of his recent researches on the process of spermatogenesis in mammals. His investigation is based upon the ox, the rabbit, the guinea-pig, the boar, the rat, the mouse, the dog, and the cat.

(1) The seminal canals of Mammalia include two functionally different elements—the mother-cells (Stammzellen) with their derivatives, and the basal-cells (Fusszellen). (2) The process of spermatogenesis is accomplished in four stages—(a) Multiplication of mother-cells; (b) formation of sperm-cells (Samenzellen) from some of the mother-cells; (c) copulation between the basal-cells and the former; (d) modification of the thus united sperm-cells into spermatozoa. (3) All the four acts occur by successive displacement (schubweise).

(4) The multiplication of mother-cells occurs by indirect cell-divisions in the most external cellular layer of the seminal canal. (5) The formation of a row of sperm-cells is effected by a preparative alteration in the position of the mother-cells. The latter multiply by indirect division in the inner layers of the canal, and some of the results form reserve mother-cells.

(6) After the perfecting of a generation of sperm-cells, the basal-cells in the outermost zone conjugate with them, each basal-cell uniting with a number of sperm-cells. (7) Contemporaneously with or immediately after the occurrence of this conjugation the sperm-cells begin to be modified into spermatozoa. (8) The nucleus forms the various parts; the cellular body is dissolved. (9) The portion of the nucleus nearer the point of copulation forms the head, the reverse the tail. (10) During their entire modification the sperm-cells remain in organic connection with the basal-cell, and form by active and passive modifications of the latter a bundle of spermatozoa. (11) They are expelled as they actively or passively lose their connection with the basal-cell, and are pressed out laterally by the proliferation of adjacent elements.

(12) The various steps occur regularly in each part of the tubule, so that certain events in successive rows of seminiferous cells always coincide. Thus the close of a period of modification coincides with that of the multiplication of sperm-cells; the beginning of the former occurs at the same time as the preparative alterations of the mother-cells; these preparative changes always occupy the same time as two periods of modification; two rows of sperm-cells are always in process at the same time; the close of each process of modification is contemporaneous with the perfecting of a generation of sperm-cells, so that at the end of modification the material for the next period is already in progress. (13) In each portion of a seminal tubule it is therefore possible to have a periodic secretion of spermatozoa, and an unbroken succession. (14) The secretory periods in the different portions of the tubule do not coincide. (15) By a regular alternation of the secretory periods in the different parts of the tubules there is a possibility for continuous secretion throughout the mammalian testis.

Significance of the Yolk in Osseous Fishes.†—Mr. E. E. Prince is of opinion that the yolk of the Teleostean egg is accessory, an appendage not directly contributing to the building up of the tissues, but mainly serving to furnish pabulum to the delicate and rudimentary embryo on emerging from the egg; the presence of large oleaginous spheres in the yolk confirms this view, for these globules appear to have no intimate connection with development.

If this view be correct, the germ is discoblastic, and the invaginated

* Arch. f. Mikr. Anat., xxx. (1887) pp. 49-110 (3 pls.).

† Ann. and Mag. Nat. Hist., xix. (1887) pp. 1-8 (1 pl.).

rim must be regarded as the primitive enteric involution, like the inflected are in Elasmobranchs or Amphibians. The important feature in the teleostean egg is that the germinal matter is so concentrated at one pole as to have little more connection with the yolk than that of juxtaposition; if this be so, a less distorted and more primitive condition may have been resumed; this supposition explains how, with a great bulk of yolk, the blastopore of osseous fishes is symmetrical, and coincides with the entire inflected margin of the germ.

Development of *Ichthyophis glutinosa*.*—Herren P. and F. Sarasin found two kinds of dermal sensory organs in the skin of the larvæ and the oldest embryo of *Ichthyophis glutinosa*. The nervous elevations which are found in other Amphibia are very well developed; beneath each organ the nerve forms a small ganglionic swelling, the elevations are set on a papilla of the cutis which incloses a large blood-sinus, and through the middle of this the nerve passes. The basal processes which the authors first regarded as nervous are now looked upon as being connective-tissue-fibres.

In addition to these there are organs of another kind in the skin of the head; these are flask-like structures with a narrow neck open to the exterior; as a rule, these organs consist merely of two layers of cells, the inner being truly sensory, and the outer supporting; the sensory cells have long stiff hairs which project into the cavity of the organs, and on them there moves a refractive club-shaped body, which is so held by the hairs that it nowhere touches the wall of the organ; we seem here to have to do with a true dermal auditory organ, and it is interesting to observe that the sensory cells of this dermal organ are exactly like the auditory cells of the true ear of *Ichthyophis*. The club-like body is easily dissolved, and appears to be formed by the secretion of the supporting cells of the organ. The resemblance of the organs of the lateral line to auditory organs has been frequently noted; here, in *Ichthyophis*, the organ may be justifiably called a subsidiary ear. Later in development it appears to undergo glandular degeneration.

Why do certain Fish-ova float?†—After referring to a statement by Prince as to the buoyancy of certain fish-ova, Mr. J. A. Ryder gives some notes on the subject.

There are three chief types of buoyant ova: (1) Those in which the specific gravity of the yolk is diminished, as in the cod; (2) those in which large oil-drops in an excentric position aid in causing the eggs to float; and (3) those in which a single large oil-drop causes the ovum to float even in fresh water. These types are connected by intermediate forms. As a rule the buoyant ovum has a single large oil-drop imbedded in the vitellus at the opposite pole to the germinal disc; buoyant ova float singly; are transparent; have thin membranes which do not adhere. *Macropodus venustus*, a fresh-water form, has buoyant ova, in which the relative volume of the oil-drop is greater than in any other form; and in this form the oil is the sole cause of the buoyancy, since the plasma, when freed, sinks. With the exception of this ovum, buoyant ova require water of a greater density than 1.014.

Fermentations by Protoplasm of a recently-killed animal.‡—M. Fokker states that he has been able to demonstrate that the fermentations which, since the experiments of Pasteur, it has been usual to regard as due to microbes, are produced also by the protoplasm of a normal tissue. If a

* Zool. Anzeig., x. (1887) pp. 194-7. † Amer. Natural., xx. (1886) pp. 986-7.

‡ Comptes Rendus, civ. (1887) pp. 1730-2.

small portion of an organ is taken from an animal that has been recently killed, with every precaution against Bacteria, and if this portion be placed in a sterilized medium and treated in a digester, it can convert sugar into acid and starch into glucose; but the most careful investigation by the Microscope and by cultivations cannot demonstrate the presence of microbes. After some hours, the production of acid is arrested owing to that which has been formed stopping the action of the protoplasm, but the formation goes on again as soon as the acid is neutralized by a suitable quantity of potash. The only difference between the action of the protoplasm and that of microbes is one of quantity; that being smaller in the former case.

The author thinks that these experiments prove that the difference lies in the reproductive power of the microbes; he has nothing in common with Liebig, for in his experiments the tissues do not decompose, but feed themselves and continue to live; the only symptom of decomposition is the destruction of the nuclei. "A tissue removed from a healthy animal and digested in a nutrient medium does not multiply, but it does live, and the fermentation to which it gives rise is a proof of it."

Embryo-chemical Investigations.*—Herr L. Liebermann has investigated the chemical constitution of various portions of the eggs of fowls. (1) The *vitelline membrane* was dexterously isolated, and purified, subjected to various qualitative tests, and finally analysed. The average result of analysis gave a composition unlike that of any known albuminoid, viz. C 46·21, H 7·55, N 12·20, S 3·62, O 30·42, in percentages. (2) The *chalazæ* gave similar qualitative reactions, but the percentage composition was different, e. g. C 48·26 or 47·94, H 9·81 or 8·07. (3) *The membranes penetrating the albumen* also turned out to be different, e. g. C 50·95 and H 7·24 per cent. The three substances are thus different from one another and from albumen. They have had separate origins or have arisen from albumen by different processes.

Concentrated caustic potash not only swells the vitelline membrane, but causes it to adhere to glass. Prof. Liebermann took advantage of this to study the effects of reagents on the germinal disc. It was also tested *in situ*. The detailed results are communicated. It consists principally of albuminoid substances, but lecithin or something similar is also present. The presence of sulphur (albumen) was also demonstrated in the germinal spot, which became quite black after treatment with strong alkaline lead solution.

B. INVERTEBRATA.

Otocysts as Organs of Locomotor Orientation.†—Prof. Y. Delage has made a number of experiments with a view of determining the functions of the otocysts of various Invertebrates. His results, put shortly, are to this effect: the destruction of the otocysts produces a disorganization in the power of locomotor orientation in animals subjected to it; this result is due to the abolition of the functions of the organ, and not to its excitation or to the irritation of a nerve connected with it; the almost total suppression of visual and tactile sensations does not produce any effect of this kind; sight and touch may, in a certain degree, take the place of the destroyed otocysts, but in most cases the locomotor disorganization is only diminished by the indications afforded by these two senses. The otocysts, in addition to their auditory function, play the part of organs which regulate locomotion, and they probably do this by provoking, in a reflex manner, the corrective

* Math. u. Naturw. Ber. aus Ungarn, iv. (1886) pp. 66-77.

† Arch. Zool. Expér. et Gén., v. (1887) pp. 1-26.

muscular actions which maintain the body in its desired course, and in its normal orientation during the whole period of movement. There are good reasons for believing that these organs also send to the cerebral ganglia true sensations which inform the animal as to the movements of rotation which are actively or passively effected by its own body. These sensations, as well as the preceding reflex acts, may be provoked by mechanical action exercised, during the movements, by the fluid or by the otoliths on the nervous terminations in its walls.

As to the interesting question, which of the two functions—auditory and regulative—is the more important, the author suggests that in the animals which move but little—such as the Lamellibranchiata—the auditory functions may be the more useful, while in Cephalopods and Crustacea he has no doubt that the regulative is the more important.

To the obvious objection that may be raised against this new theory—the fact that there are a number of Invertebrates which move about and do very well without otocysts—Prof. Delage urges that the otocysts are not the only organs that are capable of performing this regulative function; in some, as e.g. *Mysis*, the organ of sight so well performs the function of the otocysts, that the ablation of the latter is not noticed so long as sight remains uninjured; and we may, therefore, suppose that in Insects the absent otocysts are entirely replaced by the eye.

If this be so, and if there is no other organ which specially replaces the otocysts, we ought to prove in Insects, by the ablation of the eye, the same disordered locomotion as obtains in Crustacea and Cephalopoda when the otocysts are destroyed. On this point the author has made a few experiments which appears to confirm his views, but he promises to make a more extended investigation into the subject.

Pelagic and Littoral Fauna of North German Lakes.*—Dr. O. Zacharias has investigated the pelagic and littoral fauna of the North German lakes. He found twelve species and six varieties of pelagic Entomostraca, *Bosmina crassicornis* and *Temorella lacustris* being new species; the former was worked out by Prof. Lilljeborg; thirty-one littoral forms and two ectoparasites are enumerated; attention is specially directed to a completely rosy-red variety of *Sida crystallina*; the red pigment was in the hypodermis of the carapace.

No Hydrachnida were found in the central zone of the large lakes; thirty-one species were found near the shore.

As to the Rotatoria, attention was only given to those genera and species which are constant members of the pelagic fauna, and which indicate it by special characters of organization, such as the completely glassy transparency and absence of protective colours in some species, or by the possession of spine-like cuticular processes such as are developed in not a few species of *Anuraea*. It appears that these processes serve to support the delicate animal in the water.

The most common cilio-flagellate is *Ceratium hirundinella* Bergh; although *Dinobrya* are exceedingly common in Swiss lakes, there was no indication of them in those of North Germany.

Of Turbellaria, *Bothrosomostoma Esseni* was observed, and a few additions made to Braun's observations on its structure; the most important part is the very peculiar character of the enteric epithelium in those individuals which contain ripe embryos; in them the enteric cells exhibited an indication to isolation, and were only loosely held together; the embryos break through the extremely thin wall of the uterus, and make their way,

* Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 255-81 (1 pl.).

at the point of least resistance, into the enteric cavity, and so escape by the mouth to the exterior. Although this phenomenon has been observed by Graff in several Proboscidea, it has never yet been seen in the family of the Mesostomida. *Castrada radiata* and *Gyrator hermaphroditus* were also common, but on the whole the Turbellarian fauna of these lakes appears to be small.

Mollusca.

Anatomy and Histology of Salivary Glands of Cephalopoda.*—M. L. Joubin has discovered that the pair of salivary glands which in the Cephalopoda octopoda lies against the buccal bulb, is not, as has been thought, absent in the Decapoda, but forms a single unpaired gland which lies beneath the œsophagus, and is closely connected with the muscular bundles. The gland found on one side of the tongue of *Octopus vulgaris* by M. Livon, has been detected by the author in all the species which he has examined; the acini of which it is composed open into the space which separates the tongue from the mandible.

In Octopods, the extra-bulbar salivary glands are situated in large blood-lacunæ, and the blood which supplies them escapes peripherally by a large number of pores which are really spaces between the superficial acini. In Decapods the glands are not bathed in a blood-sinus, and the blood which traverses them is collected by a venous plexus.

If sections are made of glands taken from living animals, and very carefully prepared with osmic acid, it may be seen that in all Cephalopods, the lingual, the unpaired subœsophageal, and the extra-bulbar glands are formed on the same type. They consist of groups of acini formed of somewhat short cylindrical cells filled in their lower third by protoplasm, with a large nucleus; in the median third there is a plexus of protoplasm, and the rest is filled by rather large granulations which colour deeply. They have a close resemblance to the serous cells of Vertebrates. On the other hand, the pair of abdominal glands is formed by large conical cells, of which the narrow lower part contains the protoplasm, while the upper two-thirds are filled with large spheres of mucus; they have a remarkable analogy with the mucous cells of higher vertebrates. In the Decapoda the abdominal gland is small and acinous, but in the Octopoda it is very large and tubular. All the tubes of which it is made up are twisted in such a way as to form an inextricable plexus, the spaces in which are filled by connective fibres, or large stellate cells, or which form blood-spaces.

Development of the Squid.†—M. L. Vialleton finds that when the egg of the squid leaves its follicle and falls into the cavity of the body it is ovoid in form and consists of a chorion, the nutrient yolk which forms nearly the whole of its mass, and the formative yolk which is perfectly distinct, and forms a plate which may be easily separated. At its centre (below the micropyle), the plate is thick and formed of a granular protoplasm which passes insensibly into the peripheral hyaline portion. The germinal vesicle has already disappeared, and the first directive spindle is to be found near the centre of the area granulosa of the formative yolk. After oviposition, this last is a little displaced; at its periphery two polar bodies are distinguishable, and in the interior there are two nuclei which may be small and distant from one another, larger and closer, or fused into one. These are the male and female pronuclei; they differ in size, the smaller being the male. The first cleavage groove has the same direction as that taken by the pronuclei in approaching one another. In the second

* Comptes Rendus, iv. (1887) pp. 177-9.

† Zool. Anzeig., x. (1887) pp. 383-7.

stage there is a larger and a smaller blastomere on either side of the first groove, the larger occupying the part in which were the polar globules, and which may be called anterior or superior. In the third stage the superior commence to divide before the inferior blastomeres, and, as this becomes more marked, we get an intermediate stage with fourteen blastomeres. When the sixteen appear, two kinds of elements may be distinguished; those which are separated and individualized the author proposes to call "blastomeres," while the others, which are continuous at their periphery with the unsegmented formative yolk, he calls "blastocones." In the fifth stage the first segment (or what most authors call blastomere), counting from above, divides across and gives rise to a blastocone and a blastomere, the second divides longitudinally and forms two blastocones, the third and sixth divide longitudinally, the second and fourth transversely. In the next intermediate stages we have twenty blastocones and eight blastomeres, and later on, thirty blastocones and eighty blastomeres, owing to the transverse divisions which produce the blastomeres having been more frequent in later stages of segmentation.

The segmentation of Cephalopods calls to mind that of other Mollusca, the blastocones representing the macromeres, and being, like them, produced by a kind of budding from the blastomeres (which are the equivalent of the micromeres); the incomplete separation of the former is regarded as a secondary process.

As the blastocones divide and form rays around the blastoderm the elements produced by it separate from one another, their contour becoming less distinct; their protoplasm becomes hollowed out with vacuoles and gradually diffuses into the hyaline layer, so that in place of an element of definite form we only have a nucleus surrounded by a very small quantity of granular protoplasm. The blastomeres, then, form a circular plate (blastoderm), which will give rise to the body of the embryo, while the blastocones have formed a plasmodium which will become the perivitelline membrane; this last becomes intercalated between the blastoderm and vitellus, and in time comes to separate them completely; it is not formed, as Prof. Lankester thought, by vitelline nuclei, but arises from the first two segmentation-nuclei.

Development of Reproductive Organs in Gasteropods.*—Prof. C. Semper subjects to a searching criticism the recent conclusions of Brock † in regard to the development of the reproductive organs in Gasteropods. Brock's conclusions were based on a study of *Limax agrestis*, and may be roughly summed up as follows:—(1) At a very early stage the thin hermaphrodite duct is connected with the genital atrium and associated penial diverticulum by a somewhat thicker canal—the primary genital duct. (2) The vas deferens arises as a blind canal from the end of the penis, while the primary genital duct splits into two adjacent canals, the female and male ducts. (3) The latter is a provisional and transient structure, and from the remaining half there develop both oviduct and spermatoduct. (4) The free vas deferens, arising as above noted from the penis, unites with the female duct before it divides into oviduct and spermatoduct. (5) The spermatheca arises as a fine diverticulum from the base of the penis, at the point where the latter is inserted along with the oviduct in the genital atrium.

So much for Brock's conclusions, which Semper proceeds to criticize. The male duct is said to disappear without trace, but of this no proof is

* Arbeit. Zool.-zoot. Inst. Würzburg, viii. (1887) p. 213.

† See this Journal, *ante*, p. 58.

given. Not even Brock's own figures lend support to this conclusion. On the contrary, Semper believes that Ranzaud was right in deriving the spermatheca and its stalk from a splitting of the primary genital duct. Nor do Brock's figures seem to Semper to support his statement that the spermatheca arises at the same time as, or slightly before, the male duct begins to separate off. To Semper it appears that the male genital duct of Brock does indeed separate off from the primary genital duct, not, however, to disappear, but to become spermatheca and stalk. And further, that what Brock calls the spermatheca is no such thing, but a glandular appendage of the atrium and neck of the penis, homologous with the mucous gland and Cupid's dart-sac.

According to Brock the spermatheca is a development from the penis. But in a dissection of *Helix pomatia* made many years ago in Prof. Semper's laboratory the following interesting relation was observed and afterwards confirmed. At the point where the oviduct and vas deferens begin to separate a short duct arises, which connects the origin of the separate vas deferens with the stalk of the spermatheca. The latter in this case has retained its primitive connection with the hermaphrodite duct. The very variable diverticula on the stalk of the spermatheca, seen in so many Stylommatophora, are thus explicable as nothing more than the upper ends of the "male genital duct" of Brock. These have separated from their connection with the common genital duct, but have not degenerated to the extent observed in a normal *Helix pomatia* or *Limax*, where they have disappeared except at that point where the spermatheca arises. Each of the aforesaid diverticula is a rudiment of the upper (proximal) end of the separated male duct. Semper's opinion, then, is that the spermatheca is a lateral diverticulum from the male duct as this becomes gradually separated from the hermaphrodite duct, and that the variable diverticula on the stalk of the spermatheca are so many retrogressive developments of the upper end of the male duct, and that the connection between the hermaphrodite duct and the spermatheca above described is a frequent persistent structure (Hemmungsbildung). The paper concludes with a hit at naturalists who are ready to explain all divergent facts in terms of their theory without analysis of the facts involved.

Central Nervous System of Acephalous Mollusca.*—Dr. B. Rawitz was led to study the acephalous Mollusca from the supposition that the simplicity of the arrangement of their central nervous system would be very suitable for investigating the significance of the so-called commissures, and the origin of the nerves. He examined *Pholas dactylus*, *Mya arenaria*, *Cardium edule*, *Unio pictorum*, *Mytilus edulis*, and others.

With regard to his histological results, the following are the most important points; the central nervous system contains no apolar cells, unipolar cells are the most and bipolar cells the least common; multipolar cells are less frequent than the former, and more frequent than the latter. Some of the unipolar cells have their process going directly to the periphery, but the peripheral processes of all other cells sink into and become lost in the medullary substance; the multipolar cells are collecting-cells, and their medullary process is the homologue of Deiter's process.

The medullary substance is formed (a) of a central nervous plexus, which is formed by the intermingling of the products of the division of the medullary processes; (b) of nerve-fibrils which are formed from the meshes of the nerve-plexus; and (c) of a substance which resembles the nervous medulla of the Vertebrates, which forms the characteristic myelin, and

* Jenaische Zeitschr. f. Naturwiss., xx. (1887) pp. 384-460 (5 pls.).

which isolates the filaments of the plexus and the fibrils. The author is of opinion that the medullary substance in the central nervous system of the *Acephala* is the homologue of the white substance in the same organ of Vertebrates; cells surround the medullary substance in cortical fashion. Between the cells of the cortex and in the medullary substance there is no structure either homologous with or analogous to the neuroglia of Vertebrates. The processes of the inner envelope which sink in between the cells of the cerebral and visceral ganglia of *Pecten* are homologous with the pericellular tissue which is found in the intervertebral ganglia of Vertebrates. The peripheral nerves of the *Acephala* consist of simple axial fibrils, and exhibit no tendency to group themselves into broader fibres. There is a considerable exchange of fibres between ganglia of different names (e.g. cerebral and pedal), and an incomplete crossing between the fibres of the similarly named organs (e.g. visceral ganglia).

This last character is very interesting physiologically; if one touches an open lamellibranch on any part of its body, it immediately closes up, and, if it be a siphoniate form, it draws in its siphons; in other words, the least peripheral stimulus leads at once to a combined action of all the muscles of the edge of the mantle, of the foot, and of the shell, and must therefore be perceived in all parts of the body equally and simultaneously. The connectives and commissures may be regarded as containing a system of association-fibres of the most highly developed form. The importance of this extreme sensitiveness of the tactile organs to these (nearly always) blind animals must be very great.

The morphological conclusions to which the author has been led do not differ in any important particular from those reached by previous investigators. He differs, however, from his predecessors as to the systematic position of the *Ostræidæ*, for while they have regarded that group as a very low one, he regards it as having a high position. This view is based on the high value which the author attaches to the development of the visceral ganglion; he points out that this stands in relation to the development of the edge of the mantle as the chief concentration-point of the most important sensory organs; as the *Ostræidæ* have the most highly developed visceral ganglion, they are the highest of the *Mollusca Acephala*. Dr. Rawitz combats the view that the development of the visceral ganglion is correlated with that of the gills.

Jouannetia cumingii Sow.*—Herr E. Egger has made a morphological study of *Jouannetia cumingii* Sow., which, with its much contracted body, represents one extreme derivative of the *Pholas* type, while the long *Teredo* represents the other. The material for the investigation of this rare mollusc was obtained from Prof. Semper's Philippine collection. Instead of following the morphological details, it will be more profitable to compress the author's summary of the main results.

Most of the peculiarities of *Jouannetia cumingii*, as compared with other members of the *Pholas* family, are associated with the considerable reduction of the longitudinal axis. These peculiarities are to be regarded as modifications in more or less direct response to the external conditions of life. Those organs would be first influenced which have most to do with the external world, viz. the shell, the musculature, and the boring apparatus. The shortening of the shell is almost a mechanical result of the peculiar boring. The consequence is the approximation of the adductor muscles; the posterior one especially appears to be shunted forward towards the centre of revolution of the shell. By this shortening of what corre-

* Arbeit. Zool.-zoot. Inst. Würzburg, viii. (1887) pp. 129-99 (4 pls.).

sponds to the arm of the lever, its power would be reduced, were it not for compensation involved in an immense increase of volume and a most efficient insertion on specifically peculiar muscle apophyses. Similar adaptations are well known in other animals.

There are also secondary modifications associated by correlation of organs with the primary. The strengthening and approximation of the two shell-muscles involves a considerable reduction of the space between them. It is therefore natural that the organs in this region are modified by mutual pressure. By a shortening of its longitudinal axis the ventricle of the heart comes to lie quite transversely, the dorsal vessel exhibits a sharp bend, the posterior aorta being forced to pass for some distance in front of the ventricle, so as to reach along with the rectum (which penetrates the ventricle inferiorly and posteriorly) the upper surface of the posterior adductor. The auricles remain approximately equal in length, but their form is modified by the lateral horns of the kidney, which are insinuated between the former and the base of the gills. The same position of the organs occasions the restriction of the openings of the vasa revehentia branchiarum to a very restricted portion of the anterior end of the wall of auricle. That portion of the kidney which represents the typical pair of tubes in the most nearly related forms is also compressed longitudinally, so that it forms a simple transverse sack, the "central portion." This restriction of the secreting area must be compensated for in some way. This can only occur by the development of diverticula between the adjacent organs. There are two pairs of such structures extending forward from the central portion. The dorsal pair are insinuated between the posterior adductor and the pericardium forward to the rectum; the two lateral horns of the kidney lie between auricle and base of gills. In these the glandular epithelium is abundantly folded inwards. The shortening of the ureter is not, however, compensated for in any way, length being for such an organ of no moment. In the nervous system, the centres of which lie before and behind the region of most modification, the effect of shortening is only seen in the relatively slight length of the commissure between cerebral and visceral ganglia. In the gills, on the other hand, the marked shortening of the lamellæ is probably made up for by an increase in thickness. The shortening is also associated with the appearance of a special membrane which completely separates the mantle cavity into anal and branchial chambers. The third adductor of the shells, which has been differentiated from the pallial muscle, is also conspicuously short. The other organs, such as stomach, intestine, enteric appendages, central portions of nervous system (with the exception of the enigmatical small ganglion in front of the visceral) are not within the range of the most modified region, and show but slight deviations from the ordinary *Pholas* type.

The form of the accessory shell-pieces ought also to be interpretable in relation to external conditions. The shape of the shortened shell of the young form is of a skullcap-shape; the young animal can bore a perfectly round hole in the coral block; this dwelling-place determines the form of the fresh pieces. The shell of the adult must complete the sphere.

The mobile larva, the young boring form with toothed shell and muscular foot, the sexually mature adults, all exhibit modifications corresponding to their different conditions. These are discussed in the course of the memoir.

Jouannetia cumingii is connected with the more typical forms by a series of transitional stages. It stands itself as the extreme of a long row of forms. *Pholas dactylus* and similar forms may be taken as primitive types of the open Pholadidæ. The closed types pass in their young forms

through a stage resembling the latter, but this is less marked in the extreme *Jouannelia*, where the closure of the anterior mantle aperture by the mantle diaphragm occurs at a very early stage when the anterior shell opening and foot are still present. This also can be interpreted in association with external conditions and the form of the young shell. The memoir, of which the results are outlined above, is obviously conspicuous for its attempt not merely to chronicle, but to rationalize the morphological facts.

Molluscoida.

a. Tunicata.

Normal and Teratological Embryology of Ascidians.*—M. L. Chabry has investigated the normal embryology of *Ascidia aspersa*, and has also made a number of experiments and observations on artificially produced monsters.

In its normal segmentation the egg of this species has considerable resemblance to that of *Clavellina rissoana*, as described by E. van Beneden and Julin, and that of *Clavellina* sp. studied by Seeliger. Notwithstanding the apparent irregularity of the segmentation, it has been found possible to homologize the early cells with those of animals not closely related, and these points are explained by the aid of a diagram.

In the formation of the blastodermic layers *A. aspersa* most closely resembles *Phallusia mammillata*; attention is drawn to the segmented condition of two lateral mesodermal bands as an indication of metameric segmentation; the author establishes the primitively double character of the eye, otolith, and notochord.

With regard to the origin of normal monsters, the author shows that most arise from monstrous germs formed by certain parents; the following are the chief points in monstrous formations:—There is a deviation of a facet of segmentation. Segmentation is limited to the nucleus, or is retarded, or does not happen; the cells migrate abnormally, or fuse, or die. The number of monstrous forms is, naturally, immense, and they are so connected one with another as to render a single natural classification quite impossible.

The experiments made on the production of monsters have an interest to the general physiologist, or to the student of the special facts of embryology and teratology. As to the former, we have evidence that the production of "traumatismes cellulaires" causes the affected cells to change in form, consistency, and appearance in a manner which is as sudden as it is remarkable. They die rapidly, while the cells which have not been affected undergo correlative changes in form and position; from this the author concludes that each blastomere has a natural form, different from that which it can take in the egg, where it is in contact with the blastomeres. The blastomeres, are, in fact, ovoid, elastic masses, movable on one another; the actual form of each of them and their reciprocal action are the result of a mechanical equilibrium, due to their attraction, their natural form, and their hardness. Every segmented ovum, whether normal or abnormal, is a system in equilibrium, and it is impossible to alter the position or the form of any one of its parts without the others passing spontaneously and immediately into another state of equilibrium. The reciprocal attraction or cohesion of the blastomeres is also the physical cause of other phenomena; it explains the continuity of the dorsal cord which persists in most monsters, the integrity of the ectoderm, and so on.

* Journ. Anat. et Physiol. (Robin) xxiii. (1887) pp. 167-319 (5 pls.).

There are other phenomena which are not purely physical, but are of a vital nature; these are the amœboid deformations. M. Chabry has found that these do not take place by chance, but that certain deformations are repeated in exactly the same way for every cell in the normal egg. Each blastomere is, therefore, characterized, when in the normal state, not only by size, form, and proper position, but by a succession of determinate forms.

From the teratological point of view, it is of interest to note that injury to a blastomere results in the suppression of development of the organs potentially contained in that cell; but at the same time it is to be noted, that it occasionally happens that by the death of one cell the power of the survivors is changed, and they then give rise to parts which, in normal circumstances, they would not have produced.

B. Polyzoa.

Development of Cyclostomatous Marine Bryozoa.*—Herr A. Ostroumoff did not succeed in finding any earlier stage than one which consisted of epiblast and endoblast, such as has been figured by Metschnikoff in cross sections; in longitudinal sections the author found at the equatorial plane, on either side of the embryo, three large epiblast cells; these correspond to the corona or ciliated zone which exists in the larvæ of other marine Ectoprocta, where it consists of a row of long cells. The embryo grows rapidly; when the cells of the vegetative pole invaginate to form the sucker cavity the embryo has a remarkable resemblance to a gastrula. Later on the circular fold which is to form the mantle appears round the animal pole; its cavity is not formed by the insinking of this pole, but in consequence of the growth of the margin of the fold. With regard to the share taken by the endoderm, Barrois and Metschnikoff differ; the author detected a small endodermal cavity, the wall of which was formed of small flattened cells, but at the sides the walls were seen to be breaking up. At the end of the period of embryonic development there is no sign of this cavity. Herr Ostroumoff thinks that Metschnikoff took the mantle-cavity for the endodermal one.

The larva, after swimming about freely for some time, attaches itself by its sucker, the hind wall of which is extended into a broad round basal plate, which secretes largely a cuticular substance on its free surface. The mantle bends down and fuses with the periphery of the basal plate, the fusion occurring in the part where are the higher, apparently glandular cells. The ring-like vestibulum becomes completely closed, the cilia soon cease to move, and the cells that bear them fall away. At one point the ectodermal cells become differentiated in the form of a cellular plate which becomes more distinct a little later on; this is the ectodermal rudiment of the polypide. The period at which the plate becomes marked off varies with various Cyclostomata.

A striking point is the development of a special endothelial sheath around the nutrient tube; this is a temporary structure, which, after a time, completely disappears.

The stage which the author, with Barrois, looks upon as that of the primitive Bryozoon, presents the following characters; it consists of two surfaces divided by a cleft which leads into the vestibular ring; the vestibule is formed by the ciliated cells of the larval skin and the anterior wall of the sucker; one of its surfaces may be called the pallial, since it is formed at the expense of the walls of the mantle-cavity, while the other is the basal

* MT. Zool. Stat. Neapel, vii. (1887) pp. 177-90 (1 pl.).

surface and is formed by the hinder wall of the sucker. In the succeeding stages the vestibular ring begins to disappear, and the boundaries between its two surfaces are formed by the glandular cells; at the expense of the pallial surface the tube of the primary zoecium is formed, and at that of the basal the base of the tube. The zoecium gets the form of a casket, and this the author looks upon as a primary form, regarding the tube as having been phylogenetically acquired later on. The basal side soon gives rise to a lobate outgrowth, which, from its mode of development, appears to be homologous to the stolon of the Vesiculariidae.

In *Crisia*, gemmation obtains without the basal wall taking any part in it; among the Chilostomata the same appears to be true of *Bugula*.

The author regards the cephalic amnion-cavity of *Sipunculus nudus*, as described by Hatschek, as comparable to the mantle-cavity of these Bryozoa. All these structures belong to one of two types; there are either two investments which disappear when the animal takes on its definite form, as in *Pilidium*, or the larval integument alone disappears as in Desor's larva and *Sipunculus*. In the Bryozoon the investments pass into the organism, where they are used as food. This is the difference between these structures in various worms and in the Bryozoa, and is sufficiently explained by the absence of the functional nutrient tube during metamorphosis. In typical cases (Chilostomata and Cyclostomata), the sucker belongs to the first type, and its thinner anterior wall represents the amnion; but the mantle belongs to the second type. In the freshwater Bryozoa the mantle belongs to the first type.

Development of *Alcyonella fungosa*.*—Dr. A. Korotneff draws attention to a remarkable peculiarity in the development of *Alcyonella fungosa* which has not yet been noticed. After the development of a perfectly typical planula there appears a circular fold, which, later on, forms a cap which invests the anterior part of the body. Metschnikoff thought that this cap appeared rather late, while Reinhard was of opinion that the developing fold appeared before the buds of the polypide. Dr. Korotneff himself found that the fold might apparently arise either before or after the buds. This difference led to the following discovery; if the planula possesses two differentiated layers, and is of an elongate form, but without buds, there arises around and a little above the middle of the planula, a circular fold, which consists only of ectoderm, and becomes closely attached to the inner surface of the oöcial sac; at the point of junction the cells of the inner layer become altered in the same way as those of the fold, and there is seen a close circular fusion of the planula with the oöcium; this line of fusion becomes broader and band-like, and there is thus formed a true zonary placenta. Reinhard took the commencement of the formation of the placenta for the formation of the cap, but the true cap, as Metschnikoff rightly observed, arises much later; after the connection of the planula with the oöcium is effected, there appear at the upper pole of the planula two buds, which are rightly regarded as finger-like depressions of the wall, and which consist of ectoderm and endoderm. After the appearance of the buds another fold is developed in the middle line, a little below the zonary placenta; this may be distinguished by consisting of both ecto- and endoderm. As this second fold grows it pushes the placenta upwards; this latter at the same time begins to undergo degeneration—the cell-boundaries begin to disappear, and granules appear in the cells; the zonary placenta becomes a mass which occupies the whole upper part of the oöcium, and it is possible that the

* Zool. Anzeig., x. (1887) pp. 193-4.

degenerated placenta serves as food for the developing polypide. If the planula of *Alcyonella* be compared with the annelid larva, the two folds may perhaps be regarded as two metamorphosed ciliary bands.

Characters of the Genus *Lophopus*.*—Mr. S. O. Ridley points out the unnatural characters by which genera and species of Phylactolamæatus Polyzoa are distinguished: as exemplified in the separation of *Alcyonella* and *Plumatella*, which differ from one another chiefly in the "manner of connection between the tubes of the colony." He gives Allman's diagnosis of *Lophopus*, as well as Jullien's addendum to it, but the discovery of a new species necessitates the withdrawal of that portion of the latter's definition of the genus with regard to the spines of the statoblast.

Lophopus Lendenfeldii n. sp. is described, this being the first time the genus has been recorded from Australia; examples were also found in the Paramatta river, New South Wales. The new species differs from *L. crystallinus* in the absence of the terminal spines to the statoblast, and in the knobbed form of the inner end of the endocyst.

Arthropoda.

Simple Eyes in Arthropods.†—Mr. E. L. Mark is of opinion that Mr. Loey's observations settle some of the disputed points regarding the eyes of spider-like type. The formation of the retina from the epiblast, independently of the cephalic ganglia, settles the controversy so far as its hypodermal origin is in question. Some speculations are offered as to the causes and the real significance of the hypodermal infolding which accompanies the formation of ocelli. The first difficulty is this: if the retina, which is formed by a process of inversion, was once a normally located portion of the hypodermis, how could it have remained functional during the process of inversion? and, in the next place, what led to that inversion? It may be assumed that the primitive eye was composed of a single layer of modified hypodermal cells occupying the normal position (perpendicular) in relation to the surface of the head; that the proximal ends of the sensory cells were in connection with the nervous centre by means of nerve-fibres, and that the bacilli were formed in the distant or free ends of the cells. It seems to be reasonable to suppose that all the triplostichous eyes have passed through a condition of simple sac-like depression, in which the retinal cells were not originally inverted. From this two conditions have arisen: (1) By a closing together and fusion of the lips of the original depression a more or less voluminous cavity (filled with a so-called lens) was formed in front of the still uninverted retina, and behind a double layer of hypodermis: such a triplostichous condition obtains in *Peripatus*. (2) By an approximation of the walls of the depression the cavity would be reduced to an axial fissure; the cells corresponding to the "outer cornea" in the first case become the lentigen, those corresponding to the "inner cornea" become a vitreous body, while the retina still remains uninverted: this is the condition described by Grenacher in *Dytiscus*.

Two ways are suggested in which a change due to the action of the light may have been brought about: one is that light gained access to some portion of the periphery of the eye-bulb through other parts of the cuticula than that which originally served for the transmission of light, and that thus what was practically a new eye was developed out of a portion of the already existing retinal cells; to support this view we have the anterior median eye in *Agelena*, which, very probably, previously existed in the

* Journ. Linn. Soc. Lond., xx. (1887) pp. 61-4 (1 pl.).

† Bull. Mus. Comp. Zool. Camb., xiii. (1887) pp. 49-105 (5 pls.).

condition of a functional monostichous eye, the deep ends of whose retinal cells were directly continuous with the optic-nerve fibres; in the earliest stage of the present eye, before the appearance of the bacilli, the nerve-fibres emerge from the outer and posterior border of the retinal infolding immediately underneath the lentigen; on the development of the bacilli the fibres emerge further and further back from the surface of the head, until at last the nerve is separated by a considerable interval from the lentigenous cells. As the author points out, "this is exactly what might have been expected if the eye had been developed phylogenetically by the inversion of a layer of cells which were already in functional activity before the process of inversion began, and the deep ends of which were connected with the optic nerves. It is also consistent with the formation at the deep ends of the retinal cells of secondary bacilli, which may be regarded as the physical cause of a recession (ontogenetic) of the place where the optic nerve emerges." It is possible that the primitive bacilli do not in all cases completely atrophy; such a hypothesis would, at any rate, explain the problematic bodies which are found in the retina of scorpions—the phaospheres of Lankester and Bonnier.

The tapetum, to the presence of which it is possible to ascribe the retention of the original bacilli, does not seem to owe its iridescent scales to the cuticular secretions of the hypodermis. Mr. Mark thinks it more likely that the tapetum is formed from cells which grow from the apex of the original retinal involution into the cavity formed by that involution, and that they take the form of an outfolding. There is reason to suppose that the course of the optic nerve-fibres through the post-tapetal layers is a secondary condition; if, as is probable, post-nuclear eyes were developed from functional monostichous eyes, the deep ends of whose retinal cells were directly connected with the nerve-fibres, the fibres should retain their connection with the deep ends of the cells, and should, even in advanced stages, exhibit a course similar to that pursued by the nerve in "pre-nuclear" eyes at an early stage; but, instead of this, they traverse the post-retinal layer. This, however, is only a modification, and not a fundamental difference.

a. Insecta.

Directive Corpuscles in Eggs of Insects.*—Dr. F. Blochmann is of opinion that a sufficiently large number of eggs of Insects have now been examined to justify us in speaking definitely. In *Blatta* and in the Aphides directive corpuscles are formed in exactly the same way as in most other animals; but in *Musca* there are certain modifications; to put this in another way, we find that the more primitive forms, the Orthoptera and the Hemiptera have retained the primitive mode, while there are changes in the more differentiated Diptera; this may, perhaps, be correlated with what we know as to the various secondary modifications which obtain in the development of *Musca*; at any rate, it is striking that these cenogenetic processes should be observable in the very earliest stages of development.

In *Blatta* we can with absolute certainty, and in *Musca* with great probability, assert that the point of exit of the directive corpuscle marks the dorsal side of the future embryo, and herein the eggs of insects agree with those of other animals. It is still more important to note that this point of exit marks the animal pole, and may be taken as a fixed point in the topographical relations of the germinal stripe.

* Morphol. Jahrb., xii. (1887) pp. 544-74 (2 pls.).

In those eggs of the Aphides which develop parthenogenetically there is only one directive corpuscle, and therefore only one directive amphister; in the eggs that require fertilization there are two quite normal directive bodies. Weismann has made a similar observation with regard to the summer eggs of Daphnids, in which there is only one directive corpuscle.

Post-embryonal Development of Muscidae.*—Prof. A. Kowalevsky observes that in the larva (and even in those which have just escaped from the egg) of the Muscidae we find the rudiments of a number of organs which have no function in the larval stage; these imaginal organs develop more slowly than those which are functional in the larva. In addition to the already well known imaginal discs we find special imaginal rings and cells for the enteric canal, and special cells and groups of cells which form afresh the muscles of the imago. Ectoderm, mesoderm, and endoderm have their proper imaginal rudiments, which do not predominate in development until after the metamorphosis of the larva; when the pupal stage arrives the growth of the larval organs is ended, and the larval skin and muscles are inactive; they are now useless and are a disturbing element for the developing imaginal body, but they are seized and destroyed by the phagocytes. Special observations were made on the muscles, glands, and hypodermal cells; the muscles have the same appearance as in the larvæ, and the hypodermal cells have absolutely the same structure, so that we cannot have to do with dead or dying organs. The contents of the nuclei escape from them in the same way as the contents of the cell of *Spirogyra*, when attacked by *Vampyrella*, and this shows us that we have to do with living nuclei. As the whole phenomenon was studied in stained preparations and sections, the author thinks it well to add that the tissues and organs seized by the phagocytes exhibit the same relation to the staining reagents as do the functional organs of ripe larvæ; were these tissues dead, the appearance would be different.

The fact that the phagocytes do not seize on the freshly forming organs and tissues, but only upon those whose function is accomplished, shows us that the developing and actively living organ is not seized upon by the phagocytes; there must, in fact, be a certain functional weakness which permits of the organs being attacked by phagocytes. It is more difficult to explain the case of the fat-cells, but it may be suggested that these cells lose their power of assimilation during the metamorphosis, and so come into the category of weakened organs. The fact that the useless organs are not simply cast off, but eaten, digested, and converted into a fluid condition for the developing organs, is an example of the economy of the organism. All larvæ which cannot use up these weakened organs require more fat and other reserve material than those which use their muscle and larval integument just as if it were a prepared food; the latter is clearly the more useful method.

Histology of Insect Muscle.†—Herr R. v. Limbeck has investigated the histological differences between the two different kinds of muscles which can be readily distinguished in insects, even with the unaided eye. The observations of Retzius and Bremer, which by no means agreed with those of previous investigators, prompted the author to submit the facts to fresh examination. His material was always taken from freshly killed animals and treated in various ways. The muscles were sometimes frozen and cut at right angles to their axes, or treated with Löwit's gold-formic acid

* Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 542-94 (5 pls.).

† SB. K. Akad. Wiss. Wien, xci. (1885) pp. 322-49 (1 pl.).

method. Hardening with 1 per cent. superosmic acid was also resorted to. Hæmatoxylin alone, or in aqueous solution with potassium chromate, and gentian-violet were successfully used for staining.

When the hind leg and thorax of *Dytiscus marginalis*, for instance, are opened, the muscles in the former are seen to be beautifully white, while those of the thorax have a yellow, almost brownish colour. After removing the ventral wall and viscera, two conical white muscles are seen to spring from the dorsal portion of the posterior segment of the thorax and to have their apex inserted on the hind pair of legs. These are the white hip-muscles (Hüftmuskeln) which work the last pair of legs in and out. When these are removed, there are seen in front the yellowish-brown muscles which pass as strong beams between dorsal and ventral surfaces, and belong to the mechanism of flight.

I. *The muscles of flight* (in *Oryctes nasicornis*, &c.) are (a) very soft, and break up most readily into bundles of fibrils, which are surrounded by an extremely abundant intermediate substance of a somewhat fatty nature with "interstitial granules," probably with a nutritive function. (b) The bundles of fibrils are not only surrounded by very abundant tracheæ, but these penetrate into the bundles, and form fine ramifications round the several groups. (c) These fibril bundles exhibit no sarcolemma nor nuclei, and thus differ markedly from the muscle-fibres of Vertebrates. The probably rich nutritive supply afforded by the abundant interstitial substance, and the most efficient oxidation secured by the ramification of the tracheæ, are in obvious association with the high degree of activity of the wing-muscles. It is interesting that in the pulmonate spiders there are muscles very similar to the yellow thoracic muscles of insects, but differing in these important points: they include no tracheæ, the cementing intermediate substance is less copious, the transverse sections of the fibrils are much smaller, the fibrils are nucleated and apparently possess a sarcolemma.

II. *The muscles of the legs*.—Each of the muscle-fibres may be compared to a cylinder with an axial strand of non-contractile substance which is continued on all sides into extremely thin longitudinal plates, radially disposed, and extending to the wall of the cylinder. The distance between each two of these cementing interstitial substance plates is equal to the diameter of the primitive fibrils which occupy the intervening spaces in radially disposed rows. Corresponding to each of the transverse stripes the cementing plates bear ridge-like thickenings, which, in total contraction, appear as rows of spots, while the intermediate substance appears as fine longitudinal connecting lines. This is in marked opposition to Retzius's description of the central protoplasmic mass as a row of cells from which fine processes radiate out on all sides, at equal distances and in parallel planes. This the author entirely disagrees with. Deviations of detail in other insects are noted. Herr v. Limbeck refers in a postscript to an overlooked note by Rollet in the 1884 volume of the same Transactions as that in which his own paper appears. This note refers to the above differences between thoracic and leg muscles.

Halobates.*—From his investigations into the structure of *Halobates*, Dr. E. Witlaczil is inclined to differ from the view of Mr. Buchanan White who regards the genus as representing a very primitive form; Dr. Witlaczil bases his objection on the fact that *Halobates* agrees in its internal structure with other Hemiptera, so that it must be regarded not as a trunk-form, but as a type a good deal altered by adaptation to its life in water; thus it has lost its wings, and the development of the musculature which serves

* Zool. Anzeig., x. (1887) pp. 336-9.

for the movement of the two long hinder pairs of legs, has brought about the great development of the thorax.

Cecidia caused by *Nematus capreæ*.*—Herr M. W. Beyerinck has a notice of the gall produced by *Nematus capreæ* on *Salix amygdalina*. The production of the gall is undoubtedly due to the matter secreted by the poison-gland, which is, consequently, homologous with the poison of Hymenoptera aculeata; when the insect does not deposit an egg in the wound which it makes the quantity of albuminous matter poured out by the vesicle is always much less than when an egg is deposited; by careful observation it is possible to assure oneself that the size of the gall is always proportioned to the size of the wound and the quantity of albuminoid matter introduced. By an experiment in which the deposited egg was punctured by a fine needle it was shown that the gall is due to the parent and not to the egg; but, of course, in such a case the gall remains small; neither the egg nor the larva are necessary for its production, though their presence exercises a certain influence on the regularity of the development.

The author has endeavoured to discover whether there is any persistent alteration in the protoplasm of the plant or not. If we suppose that the substance implicated in the substance of the gall is, like the protoplasm of the plant, a living body able to grow indefinitely, or a substance which impresses a persistent modification on the protoplasm of the plant, we ought—if we should succeed in pushing the development of the gall as one of its parts beyond the stage at which it ordinarily stops—to find that the characters of the gall remain invariably the same. If, on the other hand, the gall-forming matter cannot either grow itself nor form a new protoplasm capable of reproduction, we ought—under similar circumstances—to find the characters of the organ, whence the gall was developed, reappear. Experiment has shown that the second is the condition which obtains; a normal leaf modified by the gall-forming material grew into a normal leaf, and a root into a root.

The galls of *Nematus* are possessed of extraordinary vitality; those of *N. capreæ* are found living long after the leaf is dead; *N. viminalis*, which is found on *Salix purpurea*, exhibits really remarkable properties; although abandoned by their inhabitants at the beginning of autumn and being surrounded by damp mould during the winter, they not only remain perfectly turgescient, but some of them are able, in the following summer, to begin a new life. Galls cannot be inherited. The specific material secreted by *Nematus capreæ*—and what is true of it is probably true of other forms—is an albuminoid substance which acts as an enzymatic body.

Honeydew of Coccidæ.†—Mr. W. M. Maskell describes the organ of secretion of honeydew in Coccidæ. While examining a specimen of *Ctenochiton elæocarp*i Maskell, he noticed the sudden protrusion of an organ from between the two dorsal abdominal lobes, and the excretion of a drop of honeydew. The insect exhibits at the abdominal extremity a deepish narrow cleft on the dorsal side of which are two rounded triangular protruding lobes lying in the shallow groove formed by the sides of the cleft. From beneath these lobes the insect rapidly protrudes a cylindrical organ, composed of a basal thickish tube, bearing at its extremity another similar, but much thinner. When this organ has been pushed out to its full extent, a minute globule of the sweet fluid appears at its tip, expands rapidly, bursts, and falls in fine spray on the leaf. The organ is then rapidly withdrawn.

The author has described similar organs, without recognizing their

* Arch. Néerland. Sci. Exact. et Nat., xxi. (1887) pp. 475–92.

† Trans. New Zealand Inst., xix. (1886) pp. 41–5 (1 pl.).

function, in the second female stage of *Cœlostoma zelandicum*, and in the adult female of the same insect.

Mr. Maskell hardly believes that the liquid serves for food for the numerous dipterous and hymenopterous insects often found on the leaves among the Coccids. The organ is only now and then exerted, not constantly protruded as in Aphides.

The honeydew excreted in drops or spray by Aphides, Psyllidæ, Coccidæ, and others, forms a glutinous medium well suited for the growth of fungoid spores. The black coating often observed on leaves, especially on the lower ones, is due to a closely woven covering of fungus. Among these fungoid growths, to which Signoret gave the name of fumagine, and which Comstock calls *Fumago salicina*, a good many Hyphomycetes and Physomycetes may be found. It is a secondary, not a primary disease, and sulphur and such-like are only at best superficial remedies.

γ. Prototracheata.

Peripatus of British Guiana.*—Mr. W. L. Slater gives a notice of a species of *Peripatus* from British Guiana which is unlike any yet named, but appears to be the same as one noticed by Prof. Jeffrey Bell from Dominica; both have refrained from giving a name to or a full description of the species, as they hope it will be described in Mr. A. Sedgwick's forthcoming monograph. We may note that Schmarda's species from Quito is not, as it should have been, enumerated, nor does Mr. Oakley's paper on *P. capensis* appear in the bibliographical list.

δ. Arachnida.

Homologues of Arachnid Appendages.†—Herr A. Lendl has studied the development of *Epeira diademata* with reference to the much discussed problem of the homologies of the appendages. The general conclusions of his investigation are as follows:—(a) The first pair represent antennæ; so their origin, position, motion, jointing, and innervation from the supra-oesophageal ganglion suggest. (b) The small tubercles under the upper lip do not in the adult look like mandibles, but this is more evident in their relatively less reduced embryonic state. In their origin, and in the connection of their ganglia with the oesophageal ring they resemble mandibles. (c) The import of the next pair (maxillæ) is evident. (d) The prosternum is no lower lip, but a portion of the sternum supporting the mandibles. No lower lip is discoverable, but the first of the four pairs of legs represent the second pair of maxillæ in insects. Their modification into ambulatory legs is no argument against this. In the first pair also the palp tends to predominate.

<i>Astacus flu-</i> <i>viatilis</i> .. }	An- tenna I.	An- tenna II.	Mandi- bula	Maxilla I.	Maxilla II.	{ Pes max. I.	Pes max. II.	Pes max. III.	Pedes abdom.
<i>Epeira dia-</i> <i>demata</i> .. }	○ {	An- tenna	{ (Embryo) Mandi- bula	{ Maxilla	Pes I.	{ Pes II.	Pes III.	Pes IV.	○
<i>Carabus can-</i> <i>cellatus</i> .. }	○ {	An- tenna	Mandi- bula	Maxilla I.	{ La- bium inf.	Pes thorac. I.	Pes thorac. II.	Pes thorac. III.	○

* Proc. Zool. Soc. Lond., 1887, pp. 130-7.

† Math. u. Naturw. Ber. aus Ungarn, iv. (1886) pp. 95-100.

Interesting New Mite.*—Herr L. Karpelles discusses a new species of mite (*Tarsonemus intectus*) which occurs on barley, and seems to have been imported from Bulgaria to the neighbourhood of Budapest. It has a twofold interest, in the first place as the cause of skin irritation and eruption upon the workers; in the second place, because the author has discovered the sexually mature forms, never before seen in this genus of pseudo-parasites.

The diagnosis of the species is as follows:—Body spindle-shaped, with a process behind the transverse groove in the male. The dorsal shield never extends over the ventral surface, except on the head of the female. All stages have a well-developed fourth pair of feet. The first joint of the third pair of appendages on the male bears two protuberances. In the male the first, in the female the second pair of feet bears an attaching lobe, which is smaller than that on the other legs.

Herr Karpelles draws the following general conclusions from his study of this mite:—(1) The mites previously described as species of *Tarsonemus* are really so, in spite of Haller's opinion. (2) Among these there may have been sexually mature forms, since the external genital organs of the female are not noticeable, and since those of the male, hitherto overlooked, are protrusible structures situated on the two last segments. (3) Presence or absence of tracheæ in parasitic Acarids is not a character of much import. (4) Dermaleichidæ, with the much modified Listrophoridæ and Myocoptidæ are the nearest relations of the genus *Tarsonemus*, which appears to unite them with *Myobia*. (5) The male of *Tarsonemus* is not only the more persistent form, but that which, on account of the structure of its fourth pair of legs, is more especially parasitic. As the oral structures of both sexes are similar, the above pair of appendages must be of most importance in causing the skin eruption on man. (6) Berlese notes *Tarsonemus* to illustrate his statement that dimorphism should be excluded from among the characters of the fully developed animals. The author maintains that dimorphism is here characteristic of the mature adults. (7) *Astoma* (also *Atoma*) *parasitica*, the larva of a species of *Trombidium*, is a most striking example of the segmentation of the posterior portion in mites, for both dorsal and ventral surface exhibit four grooves or constrictions. A bibliography is appended.

e. Crustacea.

Green Gland of the Crayfish.†—Herr B. Rawitz communicates an account of the histology of the crayfish's green gland, which has been the subject of repeated but yet incomplete investigation. A brief critical account is given of the observations of Leydig, Huxley, Wassiliew, Grobben, and others.

The gland has "the form of a mallow fruit," and consists of three very different substances, the green, the white, and the yellowish-brown. The green substance forms a kind of shell, in which the two others rest. It is thus most developed ventrally, and only a narrow fringe of it is seen on the dorsal surface. The white substance is the largest, it extends over the green, and is alone in connection with the sac. The yellowish-brown substance has a rounded conical form, lies upon and within the white, extending downwards within it to about two-thirds of the entire thickness, and occupying about a fourth of the transverse, and half of the oral-aboral diameter. It is not connected with the green substance. The terms

* Math. u. Naturw. Ber. aus Ungarn, iv. (1886) pp. 45-61 (1 pl.).

† Arch. f. Mikr. Anat., xxix. (1887) pp. 471-94 (2 pls.).

“lobe” (Läppchen) and “terminal sack” (Endsäckchen) applied to it by Wassiliew and Grobben are misleading.

The green substance consists of generally homogeneous cells, with a delicate contour, a well-defined nucleus, one or more pigment globules, which in some cases collect and escape at one pole. They closely resemble similar globules found in the white substance. They are apparently a secretory modification of the protoplasm. The cells are very readily broken; liberated nuclei occur all over the preparation, and exhibit among the numerous granules two or three sharply defined “nucleoli.” The very delicate cell-membrane can only withstand dilute acetic acid. The green substance does not exhibit “the small blind sacks” which Huxley describes. Nor is there any hint of a cuticle formed by the cells, as Häckel, Grobben, and Wassiliew assert. Nor does the epithelium of either white or yellow-brown substance exhibit any such structure. The cells of the green substance are, however, seated on a fine, delicate, nucleated tunica propria. The lumen of the tube forming the green substance is either empty, or filled with a peculiar meshwork arising from the protoplasm of the modified surrounding cells. The various coils of the tube are separated by connective tissue, which bears vessels, and includes cavities which appear to contain blood-corpuscles. In some cases Herr Rawitz detected cells which seemed to him to be ganglionic.

The white substance is characterized by the absence of the green pigment, and by the glancing appearance of the epithelium. The cells generally resemble those of the green portion. Two different regions can be distinguished, (a) that which forms a continuation of the green substance, and (b) the terminal portion—the white substance proper. The epithelium of the former is very characteristic. The cells appear to consist of two portions—the basal and larger taking up a varying amount of stain, the other remaining colourless, but bounded towards the lumen of the tube by a very narrow fringe of stained protoplasm. The nucleus lies in the stained portion, and in such a way that the pole turned from the tunica propria exactly marks the boundary between modified and unmodified protoplasm. The epithelium of the white substance proper has a quite different appearance. The cells are flatter, the protoplasm without differentiation, the nuclei elongated oval, the limits of the cells obscure. The disruption of epithelium noted above in the green substance never occurs in either of the other portions. The connective tissue between the adjacent coils of the tube is less developed than in the green substance; it is reduced to narrow strands; the nuclei are smaller and scarcer; the presence of blood-vessels is at least doubtful.

The yellowish-brown substance owes its colour, not as Grobben reports, to a deposition of irregular bodies of a yellowish-brown colour in the protoplasm, but to the presence of more or less intensely straw-coloured nuclei. These coloured nuclei are, however, in the minority; in most of the cells the nuclei are colourless. Otherwise the cells resemble those of the green substance. As in the latter, numerous elements occur containing abundant glancing globules. These are in all probability the result of secretion. The green and the yellowish-brown portions thus agree, and together differ from the white portion. The connective-tissue and contained vessels are very sparsely developed.

The secreted products found in the white portion are round dull globules, with a sharp contour, and transparent homogeneous appearance. They occur singly or in groups. Of rarer occurrence, are club-shaped products, sometimes of very considerable size. They then exhibit a double contour, a yellowish-green colour, and a brighter well-defined spot in their expanded

region. On the smaller of these, four regions—head, neck, body, and foot, can be distinguished. These are alternately dark and clear. Long cylindrical bodies (sometimes with a lateral protrusion), of a pale colour, delicate contour, and with an internal clear spot also occur. They recall the albumen cylinders found in the urine of nephritis patients. The yellowish-brown substance also occasionally secretes irregular purple bodies with an internal clear spot.

General structure.—From his investigations Herr Rawitz has come to the conclusion that the green gland consists not of one much-coiled tube, but of two, which are only united just before the entrance to the sac. Of these the longer forms the green and white substance, while the second forms the yellow-brown substance and a small portion of the white. There is never any direct communication between the green and the yellowish-brown portion. As to *function*, the author thinks that as yet, in the absence of more complete physiological investigation, it is premature to say that the green gland of the crayfish functions as a kidney.

Castration of Decapodous Crustacea by parasites.*—Prof. A. Giard describes the effects produced by the parasitic *Phyxus paguri* on the external sexual characters of *Eupagurus*.

The normal male hermit crab differs from the female in the arrangement of the abdominal appendages, amongst other things; but when infested by *Phyxus*, the male *Eupagurus* presents a similarity, in size and number of its abdominal appendages, to those of the normal female. The testes are filled with imperfect spermatozoa. Curiously enough, *Peltogaster paguri* produces no such effect on the male *Pagurus*, although rendering it sterile; but the females have their abdominal appendages modified in the direction of a normal male.

The author believes that *Peltogaster* fixes itself to its host at a later period than does *Phyxus*, rather than that the activity of the former is slower than that of the latter. Moreover, *Phyxus* attacks its host at a time when the embryonal abdominal appendages are still present. He considers that the Rhizocephala “have, in the phylogenetic series, introduced the Bopyrids into the Decapoda; the Isopods, originally parasitic on the Rhizocephala, at first infected the higher Crustacea through these, but later became parasitic directly on them.”

Prof. Giard has seen only one specimen (from Naples) of *Gyge branchialis* infected by a Bopyrid: this is a male, which possesses the simple first abdominal appendages characteristic of the normal female. The *Brachyura*, infested by *Capon*, and *Porcellanus longirostris*, infested by *Pleurocrypta porcellanæ*, show no appreciable modification of external sexual character.

Vermes.

a. Annelida.

Development of Ovum of Hirudinea.†—Herr C. Chworostansky finds that the wall of the ovary of *Hirudo* and *Aulastoma* consists of the outer membrane of connective tissue with a quantity of blood-vessels, a muscular layer which forms a plexus, and the internal cellular layers found by Iijima in *Nepheleis*; the last is lined by flat epithelial cells. The blood-vessels form various stages towards Lankester's vasofibrous tissue; the muscles are either broad with a thick clearly visible plasma and a central finely granulated plasma with large elliptical nuclei, or they have no distinctly granular plasma and their nuclei are small. There are two cords; the end

* Comptes Rendus, civ. (1887) pp. 1113-5.

† Zool. Anzeig., x. (1887) pp. 365-9.

of the one which is turned towards the tip of the ovary is pyriform, and its walls consist of a delicate wall with flat epithelium; the cords either float freely in the fluid or remain attached to the point where they were developed. In addition to these ovarian cords there are in the ovary three kinds of free cells, some of which have a distinct nucleus, while in others the nucleus is not stained by carmine, and yet others are degenerate egg-cells. The first form of cell is developed by the internal cellular layer enlarging into the interior of the ovary, and in these processes one or two nuclei become apparent; there are a number of intermediate stages between these and the second kind of cell, and it seems certain that the two kinds differ only in size and in the possession of a nucleus. In the degeneration of egg-cells the yolk-mass disappears, the nucleus and nucleolus alone remaining.

The formation of the germogen is effected in the following manner: the cells of the sub-epithelial layer, after growing into the interior of the ovary, lose their contour, and their nuclei divide. These form the protoplasmic matrix in which the nuclei of the primitive cells are inclosed. During the growth of the germogen the connective-tissue makes its way inwards. In *Hirudo*, *Nepheleis*, and others the formation of eggs begins when these cells have developed into egg-cells; at first the egg-cells are all of the same size, but later on some grow faster than others, and the latter diminish in size. In the egg-cells nuclei, with connective-tissue filaments, make their appearance, the filaments being developed when the germogen is converted into the cord.

New Genus of Lumbricidæ.*—Mr. F. E. Beddard describes the type of a new genus of Lumbricidæ from British Guiana, which he proposes to call *Thamnodrilus gulielmi*. It appears to be most closely allied to the South American genus *Anteus* by the absence of dorsal pores, position of the nephridiopores, and in the presence of a single pair of spermathecæ in the seventh segment. In both genera the setæ are similarly disposed, and are in the region of the clitellum, where the setæ are specially modified, and resemble those of *Urochæta* in form, differing, however, in the fact that both ventral and dorsal setæ are modified. The nephridia are differentiated into three series, the first of which is represented by one pair. Each gland here consists of a flattened mass of glandular tubules; in the second set, of fourteen, the glandular part of the nephridium is very slightly developed in comparison with the extremely elongated muscular sac which communicates with the exterior. In the remaining nephridia the muscular sac is provided with a diverticulum, which is nearly as long as itself. The chief points of difference between *Anteus* and *Thamnodrilus* appear to be the much greater extent of the clitellum in the former, the thickening of its anterior mesenteries, and the special modification of the nephridia of its genital segments. The representatives of this new genus are about 6 inches long and 3/8 inch broad.

Ctenodrilus parvulus.†—Dr. R. Scharff describes a new species of *Ctenodrilus* lately found by Mr. Bolton in his sea-water aquarium. It is of remarkably small size, being only about 4 mm. long, and having from seven to ten segments. It agrees with *C. pardalis* in having dark green or violet spots in the skin. The number of bristles in each of the two rows of either side is subject to great variation, and they cannot therefore be used for diagnostic purposes. The "segmental organs" are found in the head segment only; the dorsal blood-vessel is found only in the three anterior segments.

* Proc. Zool. Soc. Lond., 1887, pp. 154-63.

† Quart. Journ. Micr. Sci., xxvii. (1887) pp. 591-603 (1 pl.).

Beneath the epidermis there is one very thin muscular layer, which consists merely of the primitive longitudinal fibres which stretch uninterruptedly from head to tail. The segmentation of the alimentary canal appears to be independent of that of the body generally. With regard to the limitation of the "segmental organs" to the head, it is of interest to be reminded that a similar condition obtains in the larva of *Polygordius*.

The entire length of the nervous system lies in the epidermis. It consists of a cerebral ganglion and two commissures, which pass to the ventral surface, where they unite to form the nerve-cord; as in *Halicryptus* and *Priapulus* epithelial and ganglionic cells seem to merge into one another. No peripheral nerves were seen; the only sensory organs are two small ciliated pits, one on either side of the cerebral ganglion. No traces of reproductive organs could be found, but there is fissiparous reproduction, similar in character to that described by Kennel for *C. pardalis*. As in it, almost every segment becomes a zooid, which rapidly develops into the multisegmented form; a bud appears between two segments, and the buds are produced in the same order as new segments, i. e. from before backwards. As is well known, in Naids, the buds appear in the opposite order, and on this Semper's "proglottidentheorie" is based; but it is clear that it will not apply to *Ctenodrilus*; differentiation of the budding zones, unlike, again, what happens in Naids, does not go far until division of the animal. In all observed cases the act of fissiparous reproduction of *C. parvulus* was completed within forty-eight hours. *C. monostylos* differs in that there is no appearance of buds, the animal merely breaking up into two almost equal parts, each of which may again divide into two or more parts.

Natural History of the Genus Dero.*—Mr. E. C. Bousfield gives a history and bibliography of this genus, with notes on their habits and the nature of their tubes, with some hints as to the methods of observation. A description of the general character is succeeded by a more detailed account of the branchial apparatus.

The author regards the "segmental organ" as purely mechanical in function, in "preventing undue distension of the body by the fluid which passes through the walls of the intestine, and is doubtless charged with effete material from the blood-vessels which run in contact with it." Moreover, what is generally considered to be the movement of cilia in these organs he maintains to be due to the vibration of a membrane, the free edge of which can be seen when vitality is at a low ebb. Observations on *Tubifex*, *Nais*, *Stylaria*, and *Ælosoma* lead him to this view. The sessile habits of *Dero* necessitate some greater opportunity for oxidation of the blood than is provided in other worms by the current of water which is continually flowing in at the anus. The form of the branchial area varies in the different species, but there are never more than four branchial processes.

A systematic description is given of the asexual forms of the seven known species.

Histology of the Integument and Sensory Appendages of *Hermione hystrix* and *Polynoe Grubiana*.†—M. C. Jourdan gives an account of the dorsal cirri of *Hermione hystrix*, which seems to show that these organs are tactile. Owing to the movements of the parapodia with which they are connected they are able to exercise true tactile functions. The nerve which passes to them enters into communication with the exterior at the level of the pores, and there is a richness of innervation and a frequency of connection with the epithelial elements which shows well the specially sensory

* Journ. Linn. Soc. Lond., xx. (1887) pp. 91-106 (3 pls.).

† Arch. Zool. Expér. et Gén., v. (1887) pp. 91-122 (2 pls.).

functions of these small organs. The existence of a small accessory ganglion is of some interest, for it supports the view of those histologists who believe that every sensory nerve-ending is accompanied by ganglionic cells. The elytra are not active organs of touch, but they possess a much greater general sensibility than the ventral integument, for they contain a very rich nervous plexus, and the epidermic cells are at certain points in direct contact with the external medium. On the ventral surface tactile sensations appear to be localized in the spherical wart-like projections which are found on the integument, but they must not be supposed to be seats of "active sensation." The subepithelial nerve-plexus is connected with nerves of some size, which arise from the nerve-chain in each somite; these nerves are composed of fibrils remarkable for their delicacy. The muscular fibres, and especially those which belong to the system of longitudinal muscles, are remarkable for the irregularity of their forms; some of them are composed of two swollen extremities connected by a constriction of varying length, their fibres are neither transversely nor longitudinally striated, and they are irregularly cylindrical; they appear to be entirely composed of a contractile substance, which stains an orange-yellow with picrocarmine.

The elytra of *Polynoe Grubiana* contains a nerve-plexus analogous to that which is found in the elytra of *Hermione*, but the dorsal cirri differ a good deal in their general structure. The tactile functions are exercised chiefly by the terminal segment, and the tactile powers of the stem of the cirrus, which are so well developed in *Hermione*, are here much reduced; the presence of a large number of large glandular cells on the basal joint gives a peculiar aspect and function to these appendages.

Chloræma Dujardini and *Siphonostoma diplochaitos*.*—M. Joyeux-Laffuie cannot agree with M. Küntler in thinking that *Chloræma Dujardini*, which attains a length of 15–20 mm., can be the same animal as *Siphonostoma diplochaitos*, which is about 8 cm. long.

B. Nemathelminthes.

Tylenchus devastatrix.†—Herr T. Ritzema Bos gives a preliminary account of the structure, habits, and practical import of the nematode *Tylenchus devastatrix*, which is a too abundant cause of disease in rye. He is about to publish a complete account of his investigations in monographic form.

The first part of his paper is occupied with a history of previous investigations relating to the genus *Tylenchus*. He reviews the various forms of *Tylenchus* which have been described, and discusses them in relation to the diseases which they occasion in numerous plants. *T. devastatrix* may live on very different cultivated plants. *Tylenchi* which have been restricted for generations to one kind of plant come to differ in form and size from the same species on other plants. With them as with other parasites, slight changes appear in response to different environment. The author suggests that the free-living *T. intermedius* of de Man is the original species of which *T. devastatrix* Ritzema Bos (*T. dipsaci* Kühn + *T. devastatrix* Kühn + *T. askenasyi* Bütschli + *T. hyacinthi* Prillieux + *T. Lavensteinii* Kühn + *T. alii* Beyerinck) is only an adaptive modification.

T. devastatrix inhabits only stems and leaves, never roots. It infests certain plants specially (rye, onions, hyacinths, teasel, &c.), and causes disease. It occurs in many others, but without doing much damage. It has been recorded in 34 species, representing 14 different families of plants.

* Comptes Rendus, cvi. (1887) pp. 179–80. † Biol. Centralbl., vii. (1887) pp. 232–43.

Even in infested ground certain plants remain free. Slight differences in thickness of cell-wall, &c., mean much to the parasite. A detailed tabular survey of its relation to numerous plants is given. The persistence of *Tylenchus* for generations on one kind of plant may to a certain extent unfit it to attack another; the difference resulting is rather physiological than morphological. Just as Bacteria morphologically the same are often very different physiologically, so with *Tylenchi*; and just as a *Bacterium* may have its virulence attenuated by a given culture, so *T. devastatrix*, as far as hyacinths are concerned, may be said to be attenuated by culture for several generations on rye.

Although the *Tylenchi* are true plant parasites, it follows from the nature of most of the plants which they infest that they spend part of their life in the ground. It is different, however, with those infesting hyacinths and bulbous stems. In spring these usually migrate from bulb to leaves, retiring again to the bulb as the leaves die off. They pass from old bulb to young bulb, and thus never enter the ground. The "rye-worms" pass from the soil into the young plants, remain there and multiply till the grain ripens and the stem and leaves begin to wither. Then they retire to the soil again. The life-history varies with the plant infested. They may remain a long time, over a year sometimes, latent in the ground, probably in a lethargic state, but this can only occur in the upper drier layers of the soil.

γ. Platyhelminthes.

Relation of the Nemertea to the Vertebrata.*—Prof. A. A. W. Hubrecht devotes his memoir on this subject to the establishment of the following proposition:—"More than any other class of invertebrate animals the Nemertea have preserved in their organization traces of such features as must have been characteristic of those animal forms by which a transition has been gradually brought about from the archicœlous Diploblastic (Coelenterate) type to those enterocœlous Triploblastica that have afterwards developed into the Chordata (Urochorda, Hemichorda, Cephalochorda, and Vertebrata).

In support of this proposition it is pointed out that the Nemertea present the following Coelenterate characteristics: the presence of nematocysts in the proboscidian epithelium, the elaborate nerve-plexus in the integument and its histological features, the presence of epiblastic muscle-fibres separate from the general body-musculature, the presence and the chemical constitution of a sometimes very massive intermuscular jelly by which the other organs are at the same time surrounded, the mode of development of the mesoblast (at least in *Lineus obscurus*), which is less specialized than in most other Invertebrates, and lastly, the absence of any distinct enterocœle. The following, on the other hand, are the points of resemblance to the Chordata; the general features of the nervous system, the presence of a homologue of the hypophysis cerebri as a massive and important organ (the proboscis), the presence of tissues which may have become converted into the notochord (viz. the material of which the proboscidian sheath is built up), and the respiratory significance of the anterior portion of the alimentary tract.

Prof. Hubrecht's speculations are based on the conviction that new combinations or organs do not appear by the action of natural selection unless others have preceded, from which they are gradually derived by a slow change and differentiation.

* Quart. Journ. Micr. Sci., xxvii. (1887) pp. 605-44 (1 pl.).

With regard to the resemblances between vertebrate and invertebrate nervous systems, we must for the present be content with general points of coincidence, and must rigorously refrain from detailed comparisons. If we take the Nemertean arrangement as our starting-point, it is easy to understand the polymerous root of the vertebrate vagus and its mixed physiological duty. The author enters at some length into a comparison of the Chordate and Nemertean nervous systems. The origin of metamerism is looked for in the dangers to the rupture of individuals and their counteraction by regenerative processes.

Spermatogenesis in Nemerteans.*—Mr. A. Bolles Lee communicates an account of the spermatogenesis of nemerteans, especially of *Tetrastemma melanocephalum*. His research has special reference to Sabatier's theory of spermatogenesis. According to Sabatier the primitive "male ovule" develops on its surface a number of "protospermoblasts" round a degenerating (female) core, the "protoblastophore," and in each of the protospermoblasts the same process is repeated in the development of a second generation of centrifugal elements—the "deutospermoblasts" which are disposed around the central core or "deutoblastophore." This account the author was entirely unable to verify.

He is inclined to believe that the male elements have their primary origins from mesodermic tissue, and not, as Hubrecht maintains, from the ectoderm. (1) What Sabatier has described as a mass of non-nucleated protoplasm, was the first certain trace of the male elements recognized by Bolles Lee. But when this apparently homogeneous content of a sperm-sac was fixed, stained, and sectioned, it was found to consist of a mass of distinctly nucleated cells. (2) At a later state a median section of one of the lobes of a sperm-sac exhibited from the periphery centralwards, the following series of cell groups:—(a) One or two layers of large pale cells, distinctly separate, with pale nuclei; (b) a much larger region with smaller, more crowded cells, with more distinctly chromatic nuclei, and more or less regularly linked together by strands; (c) within this spermatozooids, more or less adherent, with their heads towards the periphery and their tails in the lumen. This appearance is interpreted as a succession of spermatogonia (S^1), spermatocytes (S^2), spermatides, and spermatozoa from the periphery inwards.

(3) The author next discusses the minute characters of these different stages which were studied in preparations fixed with osmic acid vapour. The elements S^1 are typical cells; no trace of karyokinesis was seen; but traces of binary division and certain indications of endogenous multiplication were observed. The elements S^2 are much smaller, but distinctly cellular, with very thick nuclear ribbon, either uniform or necklace-like. Some of the dispositions suggested very simple karyokinetic division. They also multiply by endogenous division. The spermatides are at first very small, but seem to increase notably in size before becoming spermatozoa. They have a cellular membrane, but only a minimum of protoplasm. Neither here nor in S^2 was a nuclear membrane demonstrable. The changes of the nucleus, the appearance of the accessory body or "Neben-kern," the formation of the tail and other modifications in the ontogeny of the spermatozoid are then discussed. Young sperms were seen swimming about with a suspended vesicle, the remnant of the cell-membrane containing a homogeneous substance, and sometimes the "Neben-kern" intact or in process of dissolution. The author believes that the membrane is not

* Rec. Zool. Suisse, iv. (1887) pp. 409-30 (1 pl.).

thrown off, but utilized. Occasionally the pseudopodic process, characteristic of the spermatide, persists in the spermatozoa.

All nemerteans observed exhibited the same mode of spermatogenesis. This mode is general and typical among animals. Sabatier's account obviously does not in any way conform with the facts above summarized.

Anatomy of *Langia obockiana*.*—Dr. L. Joubin gives an account of a new species of Nemertean from Obock. When alive it is about 30 cm. long, and is of a carmine colour; along the whole length of its body there extends a deep dorsal groove, bounded by two pads which are generally approximated to one another, but can be separated so as to widen the groove; the floor of this groove is provided with longitudinal folds; the hinder end tapers gradually. The head is of a somewhat remarkable shape—the end is a little pointed, and it then suddenly swells and becomes very wide; it is divided into four by two lateral grooves, and by a less marked ventral, and a deeper dorsal groove; it is sharply marked off from the rest of the body, both by its clearer hue and by a large and wide groove which forms a kind of neck.

When the grooves are studied in section they are seen to be lined by a continuation of the reflected skin; at the floor the epithelium is higher, and rests on a hyaline layer. Beneath this, in the midst of the plexuses of subcutaneous connective tissue there are large elongated cells arranged radially around the floor of the cul-de-sac; the prolongations of these cells traverse the hyaline layer and penetrate into the interior of the epithelium; these are clearly nervous, and may be regarded as ganglion cells, which are connected with the nerves that arise from the brain.

The skin presents the same histological characters as that of the Nemerteans, and especially of the Schizonemertini; and the same is true of the musculature.

The digestive apparatus is interesting, inasmuch as it is extremely developed in relation to the general proportions of the animal, the lateral pouches being extraordinarily exaggerated, and the true digestive tube being limited to a kind of central passage which merely connects the lateral pouches. The cæcal pouch in front of the mouth is very large, being nearly 5 mm. in length, and the mouth appears to be a hole in the wall of the œsophagus, which extends above and below it. The œsophagus itself is completely invested in a circular layer of muscular fibres which form a kind of elastic sheath to it, and must have an action on the deglutition of food. Two thick layers of lamellæ extend into the lumen of the true digestive tube and considerably diminish its capacity; they consist of a delicate layer of connective tissue covered by epithelium, which was, clearly, ciliated.

Not far from the commencement of the intestine, and behind the œsophagus, there are two opposite and parallel grooves of no great length, which possibly serve as gustatory organs. The proboscis was very delicate in proportion to the diameter of the worm; its orifice was not at the exact anterior point of the body, but a little below it, and was so arched as to reach to the median part of the cephalic region, where it was lodged in the midst of a sinus.

The circulatory apparatus of *Langia obockiana* differs only in some details from that of *L. formosa*, lately described by M. Oudemans; nor does the nervous system differ in any important characters from that of other Schizonemertini, as described by Prof. Hubrecht. No trace of sexual organs was found in the specimens which were taken in February 1886.

* Arch. Zool. Expér. et Gén., v. (1887) pp. 61-90 (2 pls.).

Development of Fresh-water Dendrocœla.*—M. P. Hallez gives a notice of his observations on the early stages of the development of fresh-water Dendrocœla. The ova, in the ovary, are not spherical, but have a long axis parallel to the longitudinal axis of the Planarian, and they are alecithal. Impregnation is effected in the uterus; when the eggs descend into the genital cloaca they become surrounded by about twenty vitelline cells, arranged radially. M. Hallez thinks that his observations are sufficiently numerous to justify him in denying the presence of polar globules. The following are the changes undergone by the nucleus; the filaments of chromatin are at the periphery, they become arranged on an equatorial plane, they separate and form a wedge whose axis runs along that of the egg, the wedge being formed of eight meridian filaments of chromatin; the filaments then become more delicate and separate at the equator, they then become drawn towards the poles, and afterwards become sinuous.

As far as the 8-stage the blastomeres are equal; after it the radial vitelline cells begin to shed out a finely granular protoplasmic substance which filters between each of the blastomeres and forms a special medium for it. In the later stages the segmentation cavity becomes filled by this fluid, which goes on increasing as the blastomeres multiply. When the cells which have primitively surrounded the egg have disappeared, those which are nearest the embryo come to their aid, and take their place; the homogeneous mass can only be considered as a medium, for it takes no part in the formation of the embryo.

Helminthological Observations.†—Dr. F. Zschokke examined, during his stay at Naples, 72 species of fishes, of which 53 were infested with parasites. Of 257 fish only 73 were quite free. Parasites are more common in Selachians than in Teleosteans. 77 species of parasites were found: 38 Cestodes, 16 Trematodes, 3 Acanthocephali, and 20 Nematodes. The first were found almost exclusively in Sharks and Rays; of 4 species the larval stage was found in Teleosteans, and the adults in Cartilaginous fishes. The Nematodes were more common in bony fishes. The author cannot agree with Dr. Oerley's generalization that a striking peculiarity of Selachian Cestodes is their small size, or that the length of the parasite is in inverse relation to the size of its host.

5. Incertæ Sedis.

Ectoparasitic Rotifers from the Bay of Naples.‡—Dr. L. Plate gives an account of the Seisonidæ, of which as yet only two genera, *Seison* and *Saccobdella*, are known. A new (third) genus is now formed, which it is proposed to call *Paraseison*. There is no hindgut in either sex. The wheel-organ may be reduced to a few tactile setæ. There are two flask-shaped glands in the hinder part of the head. The gonads are placed laterally or dorsally to the stomach. The ductus ejaculatorius of the male has smooth walls, and there are numerous flask-shaped spermatophores. There is no sucking disc to the tail, but the hinder pole of the body has the form of a hemisphere, which is beset with a row of small denticles, among which the attaching glands open. Four species of this new genus are described, under the names of *P. asplanchnus*, *nudus*, *proboscideus*, and *ciliatus*.

As will be seen from the above account, *Paraseison* differs from *Seison* in a number of details, but is at the same time clearly a close ally. The relations of the two to *Saccobdella* cannot, with our present slight knowledge of the third genus, be exactly defined.

* Comptes Rendus, civ. (1887) pp. 1732-5.

† MT. Zool. Stat. Neapel, vii. (1887) pp. 264-71.

‡ Ibid., pp. 234-63 (1 pl.).

The author has recently shown that the fresh-water Rotatoria fall into the two natural divisions of Ductifera and Aductifera, and into these fall also a number of marine forms. For the parasites of *Nebalia*, a third family, which may be called that of the Seisonidæ, must be instituted. It stands nearer the Philodinidæ than the Ductifera. As the former appear to present the most primitive arrangement of the wheel-organ, it may be supposed that the Seisonidæ branched off early from the root of the trunk of the Rotatoria. The most primitive arrangement of the sexes was a double one, and the bisexual character of most members of the class must be regarded as having been secondarily acquired. The only difficulty is presented by the masticatory organs, which in the Seisonidæ are closely of the type which obtains in the Ductifera, and different from what are seen in the Philodinidæ. The author is inclined to explain this by supposing that the masticating apparatus of the Archirotator as seen in the Philodinidæ was lost, and that a fresh and independent development obtained in the two different divisions.

Myzostoma Bucchichii.*—Dr. F. v. Wagner describes, from a single specimen dredged off Lesina, a new species of *Myzostoma*, which he calls *M. Bucchichii*. As *Antedon rosacea* was also dredged in the neighbourhood, the author thinks it may be one of the parasites of that Crinoid. The disc is about 3 mm. in diameter, and the new species is characterized by the tubercles which are arranged symmetrically in five groups on the dorsal surface. Each consists of an aggregation of four to seven papillæ of various sizes. The suckers are completely wanting, as in *M. folium*, *carinatum*, and *coronatum*.

Echinodermata.

Movements of Star-fishes.†—Prof. W. Preyer commences the second half of his Memoir on various Echinoderms by a discussion of the reflex movements of Crinoids. To what is known as to the function of the cirri as organs of attachment, he adds the observation that the cirri serve as organs of touch, and very probably test the surface to which they attach themselves. In any case they, like the pinnules, are distinguished by their reflex irritability. Even the larvæ are very sensitive. Strong mechanical, electrical, thermal, or chemical stimuli directly applied to the stalk easily cause the breaking off of the distal part of the rays. The pieces broken off do not merely, as Krukenberg reported, retain their reflex irritability for several hours, but rather for days. The irradiation of stimuli is clearly affected in Crinoids by very slight lesions; they are very sensitive to elevations of temperature.

With regard to the movements of escape made by star-fishes and brittle-stars, Prof. Preyer is unable to accept the exactness of the results of Mr. Romanes and Prof. Ewart. He does not find that they try to escape from the stimulus in a straight line, nor that if two neighbouring rays are excited the line of escape is the "diagonal," nor that if the tips of five rays are simultaneously excited there is a tendency to rotate round the vertical axis. When a caoutchouc ring was firmly placed round two rays of *Astropecten pentacanthus* there was no attempt made to escape, but after six days the rays were broken off. After rapid and strong compression of a ray of *Ophioderma* [*Ophiura*] it was not withdrawn every time, but was often moved in pendulum fashion without any attempt to escape. The answering movements of Echinoderms are much more complicated than appears at first

* Zool. Anzeig., x. (1887) pp. 363-4.

† MT. Zool. Stat. Neapel, vii. (1887) pp. 191-233 (1 pl.).

sight, and Prof. Preyer can only imagine that the just-named observers did not sufficiently vary the conditions of their experiments. Thus, to follow a straight line of escape is only one way among many. If a fresh *Luidia* be electrically stimulated anywhere on its back, it may escape in curved, zig-zag, or straight lines, and the latter do not by any means always lie between the point of irritation and the centre of the mouth. The same holds good for *Asterias*. *Ophioderma*, under the same conditions, makes quite irregular attempts to escape. With *Asterias* a strong stimulus is sometimes followed by no change of place, and *Luidia* often commits amputation. One of the most remarkable phenomena offered by Asterids is their attempt to escape from air. Thus, if two rays of an *Asterias glacialis* are placed in a narrow tube filled with sea-water, while the other three rays remain in the air, the latter will within ten minutes be drawn in, even though it were impossible, without breaking the animal, to force it through. This is an indication of the co-ordinated contractions of several thousands of muscles. After describing a large number of most interesting experiments, Prof. Preyer says it would be useless to describe more showing with what judgment star-fishes and brittle-stars free themselves from elastic rings, various coiled threads, nets, and so on. The certainty and even the elegance with which they act cannot but strike the observer, while again the number of superfluous twistings, tactile movements, and locomotor actions diminish the more often the creature is put to the test; the variations in the angles formed by two rays are quite astounding. The consensus of all the parts of a pentate or septate nervous and muscular system is no less interesting from a physiological-psychological point of view than the mechanism by which freedom is gained.

Dealing next with autotomy or self-amputation, the author commences by remarking that the fact of many animals being able, under certain conditions, to rid themselves of a part of their bodies is a physiological problem of the first rank. He finds that autotomy must not be ascribed to one cause only. Various observations dealing with this comparatively well-known phenomenon are detailed, and it is pointed out that in *Luidia*, at any rate, self-amputated pieces, when stimulated electrically, may break up into two or even three pieces; this shows, of course, that the central nerve-ring is in no way necessary for autotomy. The observations all together show that we have to do with a process of a special kind, and that self-amputation is not always a reflex action.

The succeeding chapter properly deals with the restoration of separated parts; after a reference to the well-known fact that pieces of star-fish with which no portion of the disc remains connected may regenerate the four other arms, it is pointed out that from a physiological point of view this fact is especially noteworthy; for Prof. Preyer has found that the central nerve-pentagon of Echinoderms, or at least its five angles, from which the radial medullæ take their origin, are functionally (so far as co-ordination is concerned) more important than the radial medulla itself; yet in these "comet" cases of reproduction the latter is alone sufficient to reproduce the central organ. We have, within a year, a central nervous organ of a high order formed completely afresh from a peripheral part of a lower order. The fact that regeneration of Ophiurids cannot be effected without the participation of the disc shows that, in them, the nerve-centre is physiologically much more important than in *Asterias*.

Although there is morphologically no essential difference in the value of the rays, it was thought important to test the question from the physiological side; a number of experiments were performed, but no ray was found to be of greater value than the rest; some interesting facts were,

however, brought out by these experiments. The animals were often seen to be in doubt as to which ray should go first; Asterids often turned on their axis before moving forwards, and the direction of the turning might be with or against the hands of a watch. There was a remarkable variation in the length of the latent period, one and the same individual giving a few seconds or an hour; in general the very long latent periods were observed after several experiments had been performed on the same individual. After amputation of one or more rays the latent period was increased.

Observations were made on the dependence of movements on sensory impressions; with regard to the influence of light, the results of Romanes are confirmed, and it was noticed that very slight differences in the illumination of the walls was sufficient to cause a movement of most Asterids (never of Ophiurids) from the less to the more brightly illuminated part. Experiments to test the sense of colour were all negative in their results; the photochemical sensitiveness of the skin was repeatedly observed, and it was found that there were colouring matters present which are sensitive to light; Asterids certainly seem to have specific nerves sensitive to luminous impressions and connected organically with the co-ordination centres.

The great sensitiveness of all star-fishes to alterations in the concentration and chemical composition of sea water shows a great power of distinguishing sensations, but the fact that any part possesses this chemical sensitiveness speaks against the supposition that there is any specific sense of taste. Experiments made along the lines of those used by Romanes on the sense of smell did not give constant results, but it is possible that the animals which failed to be attracted by the food were not hungry; the interesting and even entertaining recital of experiments shows that very complicated movements are made, and that, at least in a state of inanition, there is a great irritability of the specific olfactory nerves, and a close connection between these and the co-ordinating centres; certain olfactory impressions cause a rapid and direct movement of the whole animal to the place whence they came.

The experiments that have been recorded have, incidentally, given considerable evidence as to the presence and extent of the tactile sense.

Summing up the results of his important investigations, Prof. Preyer commences by calling attention to the proof that Asterids, Ophiurids, and Crinoids perform quite a series of movements, which cannot be of a purely reflex nature, but presuppose a certain intelligence; it has further been shown that the central or peripheral portions of the nervous system are functionally unequal in value; by means of the "ambulacral law" it is possible to say beforehand how a given star-fish will respond to various stimulations of its pedicels, and when stimulation will irradiate and when it will not. Others of the experiments add to our knowledge of the comparative value of poisons. A large series of observations have been made on the physical and psychical functions.

In the reflex retraction of the suckers we find coming into play the sensory nerve-fibres passing from the pedicels into the sensory ganglion-cells of the radial medulla, connecting fibres between these and the neighbouring motor ganglion cells, the motor fibres from the latter into the muscular fibres of the pedicels, sensory nerve-fibres from the dorsal integument into the sensory ganglion cells of the radial medulla, and, lastly, connecting fibres between the latter and the ganglion cells of the medulla. Similarly, reflex extension is effected by the action of the sensory nerve-fibres which pass from the skin of the back into the other sensory ganglion cells of the radial medulla, connecting-fibres between these and the motor

ganglion cells, and motor nerve-fibres from those in the wall of the ampullæ.

Further, it may be regarded as probable that the central nerve-pentagon has a different function at the angle whence the radial medulla arises than in the commissures; perhaps there are there a larger number of ganglion-cells; these points are distinguished physiologically by being the seat of higher psychical functions than is the radial medulla.

The explanation of the consensus which the five-rayed or many-rayed animal exhibits is, it is probable, to be explained, not by supposing there is a permanent "central soul" governing the five separate "souls," but that at one time one, and at another time another, central stimulus has the upper hand; the Echinodermata must be regarded as possessed of what is ordinarily called psychical activity—for Asterids and Ophiurids have sensation, will, understanding; what is peculiar to them is that mind or "soul" is fivefold or manifold, has five (or more) similar substrata which are in close organic connection with one another. Only so long as this nervous substratum is uninjured is the psychical activity able to act in harmonious co-ordination.

Circulatory Apparatus of Ophiurids.*—Dr. R. Koehler finds it necessary to distinguish in the circulatory apparatus of Ophiurids a vascular and an aquiferous system together with a system of perihæmal canals. The aquiferous system, the study of which presents no difficulties, consists of an oral circle provided with Polian vesicles and giving off radial trunks; it communicates with the exterior by means of the sand canal. The system of perihæmal canals consists of the oral circle, the radial canals, and a space which incloses the madreporic gland; the canals are divided by a partition into two cavities, in one of which are lodged the nerves and the vascular trunks; the radial canals give off lateral branches which open into the dorsal cavity of the arm, which is the continuation of the general cavity; and it is in this way that the perihæmal canals, which are not direct prolongations of the cœlom, and are even developed quite independently of them, communicate with the general cavity. The fluid found in this cavity contains the same elements as that which circulates in the perihæmal canals.

The vascular system presents quite special characters; instead of having a free lumen, the walls of which are lined by an epithelium forming a very definite layer, it consists of a series of formations made up by a special tissue; in this there are anastomosing fibres, in the midst of which there are developed cells whose protoplasm is charged with pigmented granulations, such as are found in the cœlom. This tissue is arranged in the form of fibres which make up the oral vascular circle, and the radial vessels; in the madreporic interradius, however, it forms an organ of considerable size—the madreporic gland. These structures are always inclosed in the schizocœlic spaces, the whole of which forms the system of perihæmal canals. The vascular system of Ophiurids may, therefore, be considered as a collection of structures differentiated within the perihæmal canals, which have a complicated structure, and form tissues of the glandular type in which there are developed elements which are analogous to those of the cœlom. It would appear then that the chief function of the so-called vascular system of Ophiurids is to produce these elements; in fact, cells with pale and irregular protoplasm are very numerous and closely packed in the central parts of the madreporic gland, where they appear to multiply actively; thence they pass towards the peripheral region, and as they do so they become charged with pigmented granulations; there is nothing to lead

* Ann. Sci. Nat.—Zool., ii. (1887) pp. 101-58 (3 pls.).

us to doubt that they then fall into the space which extends between the gland and its envelope, and which, as has been shown, opens into the perihæmal circle; from the perihæmal circle the elements, thus formed, can easily pass into the coelom.

If this is really what happens in the madreporic gland, the same phenomena ought to obtain, though in a much less important manner, in the other parts of the vascular system. Throughout the vascular trunk cells must be developed, which pass directly into the perihæmal canals, for the same cells and the same arrangement are found in these as in the madreporic gland.

Although it does not seem to be correct to speak of such a system as this as vascular, yet it appears to be well to retain the name provisionally, so as to design among Echinoderms generally that collection of structures which appear to be homologous throughout the group; but it must be remembered that great differences may be caused by the varying importance of different portions of the system, and by the great development in some of parts that are not present in other members of the sub-kingdom.

Leaving aside the Holothurians, the author proceeds to institute a comparison between the circulatory system of Ophiurids and that of other Echinoderms. The Asterida differ so far that the perihæmal canals, in which the different parts of the circulatory system are differentiated, communicate with other lacunæ, developed in the dorsal surface of the test, where they form an aboral ring. Owing to the situations of the madreporic plate and of the genital organs, no such system of lacunæ could be developed in Ophiurids.

In Echinoids the important difference is that the vascular trunks are placed outside the perineural spaces and do not always accompany the nervous system; the differences in the form of the vessels, and the mode of communication between the aquiferous and vascular systems are of slight importance. The arrangement of the vascular system in Echinids is too like that of Asterids and Ophiurids for us to doubt the essential homology in all these classes.

The circulatory system of Crinoids, as made known to us by the works of Perrier and of Vogt and Yung, is very different, but may nevertheless throw some light on that of the groups just considered. It has been shown that in the larva of *Comatula*, the dorsal organ gives off a bud which penetrates into the arms, and developing in the pinnules forms the sexual products; the dorsal organ is, then, a kind of central stolon, from which the gonads arise.

In Echinids and Asterids the madreporic gland becomes continuous with a circular system of canals from which branches pass off to the genital organs. The question whether we have not here indications of more close relations than have been suspected must be answered after a study of the development of the madreporic gland and the gonads of Asterids and Echinids.

Radial Symmetry of Echinoids.*—Dr. W. Haacke discusses the old question of the radial or bilateral symmetry of Echinoids. (1) He shows in the first place that it is no direct corollary of Lovén's law that these animals are really bilateral. What Lovén's researches distinctly proved was the complete homology of the parameres in all Echinoids with the exception of the Perischo-echinidæ, and that *Spatangus* has a distinct and constant median plane. But this does not prove the radial symmetry of Echinoids.

* Biol. Centralbl., vii. (1887) pp. 289-94.

(2) The second part of Haacke's paper contains an account of his studies on abnormal *Amblypneustes*,—(a) with four parameres; (b) with six; (c) with differentiated median planes; (d) with hypertrophied parameres; (e) with two madreporic plates; (f) with irregular peristomal interambulacral plates.

(3) The real question is whether the sea-urchin consists of five equivalent portions, or only of two. It is evident that in all normal cases there are five parameres, though many exhibit in the reduction of one a tendency to become bilateral. The question is arithmetical, not geometrical. Whatever be the geometric form, bilateral animals have two, and radial at least three equivalent portions. That the geometric median plane in Clypeastroids and Petalostichidæ is different from that in *Echinometra*, and that again different from the closely related *Colobocentrotus*, and that it occupies at least four different positions in *Amblypneustes* are facts not to the point. The question is arithmetical.

Only radially symmetrical animals with an unequal number of parameres greater than two, can admit of a sudden and direct increase or decrease in the number of their parameres. That is unknown in bilateral animals. Even in Clypeasters with distinct and constant median planes, the occurrence of forms with four and six rays, as noted by L. Agassiz and Desor, shows how increase and reduction may even then occur. The Clypeastroids and Petalostichidæ are just as radial as the endocyclic forms, in spite of the median plane present in the former.

But by the gradual occurrence of paired symmetry throughout the entire structure, a radial animal may become bilateral, and mutatis mutandis *vice versâ*. The difference between a bilateral with two, and a radial with three parameres, is not greater than the difference between two radially symmetrical animals with four and five parameres respectively. The distinction has in fact been unwisely exaggerated out of proportion to its real importance.

Morphological Relations of Summit-plates in Blastoids, Crinoids, and Cystids.*—Messrs. C. Wachsmuth and F. Springer discuss the views put forward by Dr. P. H. Carpenter and Mr. R. Etheridge jun. in their recent Catalogue of the Blastoids in the British Museum. The latter authors try to show that the summit-plates of Blastoids exhibit a series of variations in number and position in some degree corresponding with a similar but more extensive series of variations among the Palæocrinoidea—they both exhibit a transition from five closely united plates fully covering the summit to a set of six proximal plates surrounding a central one; the six proximal plates are regarded by Messrs. Carpenter and Etheridge as the homologues of the five oral plates of the Neocrinoidea. Messrs. Wachsmuth and Springer are, however, of opinion that the English authors have altogether failed to point out a single case in which five primary plates cover the peristome among Blastoids, and they think that the superficial resemblance in the form and position of the ventral plates of *Allagerinus*, *Haplocrinus*, &c., with the orals of certain Neocrinoids has led Dr. Carpenter to regard them as orals. It may be pointed out that these plates agree equally well with the interradians of the Cyathocrinidæ, and that, as interradians, the genera just named do not present any exceptional type in the morphological conditions of these plates. The American critics refuse to look on the "orocentral" as being anything more than a highly hypothetical plate, and they refuse, therefore, to understand how five plates, without coming into contact with the anus, were transformed into six plates or more.

* Proc. Acad. Nat. Sci. Philad., 1887, pp. 82-114 (1 pl.).

Synaptidæ of the Mediterranean.*—Dr. R. Semon has investigated not only the well-known *Synapta digitata* and *S. inhærens*, but also the *S. hispida* of Heller, and the first representative of *Chirodota* which has been found in the Mediterranean. A fresh systematic account of *S. hispida* is given. *Chirodota venusta* sp. n. is only found in the thick roots of *Posidonia caulini*; it differs from the Synaptæ in that the five radial nerve-trunks, after leaving the nerve-ring, pass out above and not through the calcareous ring; this new species appears to be near *C. dunedinensis* Parker.

S. digitata and *S. hispida* live on and not in the sand, and in their external appearance they mimic well the ground on which they live; in their tentacles quite a number of animal and vegetative functions are united; respiration is aided by the extraordinary lively circulation which goes on within their cavities; they serve as organs of attachment, and either draw their body towards the affixed object, or, if that be small, they draw it towards themselves, thus subserving locomotor or prehensile functions. They act also as digging organs, pushing aside the sand and so allowing of the intrusion of the anterior end; by seizing sand-grains and swallowing them they get the minute organisms which are found in the sand. Together with the tactile papillæ in the skin, the tips of the tentacles serve as organs of touch.

With regard to the development, minute structure, and morphology of the calcareous spicules, what is true of Holothurians appears to hold also for other classes of Echinodermata. The earliest stages were studied in larvæ of *Strongylocentrotus lividus*; the first deposit of calcareous matter was seen in the formative cells, where a calcareous granule of indefinite form, but with a tendency to a tetrahedron with compressed sides, could be made out; this tetraxial object is developed in the interior of the cell. As it grows one axis lags behind and a regular triaxial spicule arises, and these lie not in but by the cell, a thin homogeneous investment surrounding the spicule. With some difficulty it is possible to prove that the organic investment is retained by the spicule of the adult. This is best done by slowly dissolving the chalk by acids, and observing the process under a high power. In large spicules it is quite easy to detect the central canal, and it is almost certain that there is an organic axial substance in all calcareous bodies of Echinoderms. This axial substance does not appear to be a compact mass, but to consist of a fine plexus, the filaments of which are strongest in the centre. The calcareous bodies appear to consist of alternately arranged and concentric layers of calcareous and organic substances. The latter are much thinner than the former, and decrease in thickness from the centre to the periphery.

The author insists on the primitively tetrahedral condition of the spicules, and points out that in some—as the wheels of Auriculariæ and Holothurians—the tetraxial arrangement persists. A regular triaxial form is one in which the rays are set at an angle of 120° ; and it is at this angle that, without exception, all further divisions and branches are made; the further divisions made thus regularly must result in a regular network, and it is clear that the intervening spaces between the bars must be regularly hexagonal. All the complicated calcareous structures such as we find in the firm skeletal parts of Crinoids, Asteroids, and Ophiuroids, as well as the plates and calcareous rings of Holothurians, all consist ontogenetically of a network perforated by regular hexagons.

The calcareous bodies which remain tetraxial are morphologically the most interesting; in the spines of Echinoderms the fourth axis is the

* MT. Zool. Stat. Neapel, vii. (1887) pp. 272-300 (2 pls.).

primary axis of longitudinal growth; they may be seen in *Asterina* or *Pluteus paradoxus*; they are probably a good deal modified in the turritiform bodies of pedate Holothurians, but this is a point which requires further investigation. Notwithstanding the various slight differences which obtain in the hard structures the development, histology, and morphology of the calcareous bodies show a union and resemblance which help to mark off the Echinodermata from other divisions of the animal kingdom.

Cœlenterata.

Stinging-cells.*—Dr. R. v. Leudensfeld gives a useful summary of researches by himself and many others on the structure and function of stinging-cells. His account is useful both as an historical review and as a systematic summary of what is definitely established with respect to these elements. In regard to the mechanism of discharge, he sums up as follows:—(a) Hamann's stalk is a support without any active role in the discharge; (b) the granular basal process is a nerve; (c) the protoplasmic mantle is contractile, and by its contraction the capsule, open superiorly, is compressed and the thread protruded; (d) the cnidoblast admits of the discharge of the nematocyst in this way that a pressure on the apex from without is transmitted to the plasmic mantle of the cnidoblast and occasions its contraction; (e) this direct reflex action may, however, be inhibited by a voluntary nervous stimulus, so that even when the cnidocil is touched the animal may prevent any explosion.

Formation of fresh stalks in Tubularia.†—Dr. P. Mayer expresses the opinion that what Herr Klaatsch has lately taken for the formation of fresh stalks in *Tubularia* are artificial products, and he thinks an examination of his figures will show this to be the case; we have here an example of the danger of trusting solely to preserved material.

New Rhizostomatous Medusa.‡—Mr. J. W. Fewkes describes a Medusa of about 18 inches in diameter when alive, which was taken in New Haven harbour. As it appears to belong to the acraspedote family *Pilemidæ*, it may be called *Nectopilema (verrilli)*; it appears to be most closely allied to *Pilema* and *Rhopilema*, though differing from them in various particulars; it appears to connect the second division of the *Pilemidæ*—the *Eupilemidæ*—with the third or *Stomolophidæ*, and its generic characters may be given thus:—Six velar lappets in each octant; no tentacles; sixteen scapulettes; eight oral arms with numerous gelatinous filiform appendages. These last vary in size and length; the term scapulettes is the English of Hæckel's "Scapuletten" and appears to be a preferable term to the more frequently used "leaf-like appendages."

Anatomy and Histology of Veretillum.§—Dr. A. Korotneff finds that the polyps of *Veretillum* have a very complex structure, there being a differentiated nervous system and special cell-elements which cause the extraordinary phosphorescence of the animal. In the cone the ectoderm consists of epithelium, a differentiated musculature, and a nervous system closely connected with the luminous cells. The epithelial cells are much elongated and are continued into fine filaments, which pass transversely through the musculature, and there are also spindle-shaped sensitive cells which are drawn out into fine filaments. The muscular layer consists of fine filaments in which are independent cell-bodies. Between the epithelial

* Biol. Centralbl., vii. (1887) pp. 225-32.

† Zool. Anzeig., x. (1887) p. 365.

‡ Amer. Journ. Sci., xxxiii. (1887) pp. 119-25 (1 pl.).

§ Zool. Anzeig., x. (1887) p. 387-90.

and muscular layers there are bipolar and multipolar nerve-cells, whence fine filaments extend in all directions; this diffuse nervous system may be compared with that found by the brothers Hertwig in the oral disc of the *Actiniæ*. The cells of the muscular layer often take part in forming the ectodermal epithelium, and this shows that the muscular layer is not yet, in this form, completely separated from the epithelium. Below the muscular layer there are other nerve-elements which are connected with the sub-epithelial nerves, and thus the nervous system forms a network which extends through the whole ectoderm and embraces the muscular layer. This nervous layer is specially connected with the phosphorescent property of the animal.

The septa, of which there are eight, consist of a supporting lamella, on one side of which there are longitudinal muscles and on the other transverse fibres; there are also large luminous cells, and spindle-shaped nerve-cells are to be found among the muscular fibres.

The structure of the wall of the polyp is much more primitive; the ectoderm is alone muscular, but the transverse fibres contain no special cells and belong completely to the epithelium; below this are spindle-shaped nerve-cells and luminous cells; the supporting lamella contains a well-developed plexus of connective-tissue cells; the endoderm has fat-spheres and some unicellular glands.

The sexless polyps have a special significance and structure; there is no true body-wall, the septa being attached to the oral disc; the œsophagus consists of filamentar cells with long and thick flagella, and between these extraordinarily small elongated nematocysts are imbedded, the whole forming a battery of nematocysts; so that the sexless polyp may be called a stinging polyp; when the stinging organs are ejected the œsophagus is evaginated.

Two of the septa of these sexless polyps are specially developed, their free inner margin bearing a ridge made up of flagellate cells; this ridge extends from the septa to the walls of the spongy tissue of which the body of the colony is composed; by their action a constant movement of water is kept up. It should be added that the oral disc of each polyp is provided with nervous elements which bring about the evagination of the œsophagus, and there are small light-cells.

The large sexual polyps are all male, the ova being developed in the rhachis, where they form four longitudinal cords, attached to the four sides of the internal axial canal. As the eggs are placed near the asexual polyps it may be supposed that all the polyps were primitively sexual; some in time became reduced, and the female elements passed into the interior of the colony.

Protozoa.

Conjugation of Ciliate Infusoria.*—M. E. Maupas has studied the conjugation of *Onychodromus grandis* and *Stylonichia pustulata*. The former, in conjugating, is always provided with two nucleoli; in several individuals the exchange of the male pronucleus was observed, and then its union and fusion with the female pronucleus. Separation takes place a little later, and by a kind of ecdysis the separated individuals renew all their appendages, the mouth and buccal membranellæ being alone wanting; the nucleus grows and soon becomes a large clear spot which occupies the centre of the body. Around the nucleus the cell becomes darkish and opaque; this is due to the presence of birefractive corpuscles of urate of soda, and of

* Comptes Rendus, cv. (1887) pp. 175-7.

numerous granules of zooamylum, which has quite the same properties as that of Gregarines. For four days the separated individuals have no mouth; they then undergo a second shedding of all their appendages, after which the mouth appears, normally constituted; at the same time the new nuclear body elongates and divides into two. Nourishment and growth are succeeded on the next day by a second division of the nuclei. The *Onychodromi* continue to eat greedily, and thirty-four to thirty-six hours after the reconstitution of their mouth they begin to divide, and for a third time to shed their appendages; the primitive nuclear bodies are completely absorbed.

In *Leucophrys patula* conjugation is effected by small mouthless individuals, such individuals having first divided fissiparously three, four, or five times according to their size. In several cases the author has observed the exchange of the male pronucleus and its fusion with the female. The representatives of this species begin to eat almost directly after separation; the primitive nucleus is completely absorbed.

As a matter of fact, M. Maupas has directly observed the exchange and fusion of the two pronuclei in six species—*Paramæcium caudatum*, *P. aurelia*, *Stylonichia pustulata*, *Onychodromus grandis*, *Spirostomum teres*, and *Leucophrys patula*; the exchange, but not the fusion, has been seen in *Euplotes patella* and *Colpidium colpoda*; so that the exchange and fusion of the pronucleus may be looked upon as being the essential act in the conjugation of the Ciliata.

New Fresh-water Infusoria.*—Mr. W. M. Maskell communicates the results of an inquiry made by himself and four coadjutors into the fresh-water Infusoria of the Wellington district. The catalogue includes among many others the following species, of which diagnoses are given:—*Cercomonas grandis* n. sp. (very large size), *Rhipidodendron huxleyi* Kent (as at Dartmoor in association with *Spongomonas sacculus*), *Trachelomonas crenulato-collis* n. sp. (fluted tubular neck, rough lorica, absence of caudal spines), *Proterodon sulcatus* n. sp. (longitudinal furrows, narrow pharynx, inconspicuous rods), *Tillina enormis* n. sp. (long oral cilia, no vibratile membrane, two contractile vacuoles), *Tillina inæqualis* n. sp. (unequal anterior and posterior portions, shallow depressions between them), *Trachelocerca filiformis* n. sp. (posterior single contractile vesicle, elliptical sublateral nucleus), *Plagiopylla varians* n. sp. (two contractile vesicles, posterior conspicuous nucleus, variable oral fossa), *Pleuronema cyclidium* n. sp. (very minute size), *Stentor gracilis* n. sp. (slender extended stem, sudden widening of peristome, deep lateral cleft, white colour), *Licnophora setifera* n. sp. (larger than European marine forms, strong setæ instead of cilia on foot region), *Opercularia parallela* n. sp. (more cylindrical and rough than *O. cylindrata* Wrzes., without striæ), *Histrio acuminatus* n. sp. (differing from *H. similis* Quennerstedt in fresh-water habitat and acuminate posterior extremity), *Acineta elegans* n. sp. (lorica vase shaped with reversed margin, widening below edge and rapidly compressed beneath, produced downwards to a point whence a short pedicel), *Acineta simplex* n. sp. (tentacles in two groups, but much smaller than *A. grandis* Kent, and with much more rapidly tapering lorica, obtusely pointed at base).

Thalassicola cærulea.†—Herr C. J. Eberth has applied the resources of modern technique to the investigation of the minute structure of *Thalassicola cærulea*. Freshly captured specimens were placed for a short time in iodized alcohol, and then in alcoholic solutions of increasing strength

* Trans. New Zealand Inst., xix. (1886) pp. 49-61 (2 pls.).

† Arch. f. Mikr. Anat., xxx. (1887) pp. 27-31 (1 pl.).

from 40–90 per cent. After sufficient hardening the organisms were imbedded, first in dilute, then in concentrated celloidin, and cut in sections with the microtome. The sections were then stained with hæmatoxylin. The structures within the central capsule, which when intact is very impenetrable, were then readily demonstrated. The beautiful blue colour, which is probably due to the oil-globules, is removed by the alcohol, and the central portions appear brownish. The extra-capsular protoplasm appears quite homogeneous, is stained blue by the hæmatoxylin, and exhibits here and there fine strands, which extend outwards from the layer which gives origin to the pseudopodia, and share with the protoplasm of this region fine brown pigment-bodies.

The region which gives origin to the pseudopodia contains not only small, but also large vacuoles, inclosing roundish angular spherules and long strands of variable breadth, sometimes homogeneous, sometimes longitudinally striated, and often with a distinct nucleus. Higher powers reveal a fine transverse striation, and the roundish angular bodies are seen to be cross sections of these muscular strands. Since Brandt has shown that foreign bodies can only remain attached to the surface, the muscular shreds found in the layer which gives origin to the pseudopodia must either be remains of the bodies of animals which have forced their way inwards, or, if no other remnants are to be found, they must be the only portions taken up by the *Thalassicola*. How these ingested muscle-fragments find their way in cannot be answered without further observation. It was noticeable that beyond a disruption of the fibrillæ no change was detectable.

The spherical central capsule is bordered by a membrane penetrated by numerous pores without special arrangement. On surface view the pores appear to be included in a finely granular mass without pigment; on cross sections this appears to be beset on both sides with small pointed hairs, which are probably minute stumps of the protoplasmic processes penetrating the pores.

The intracapsular protoplasm exhibits three zones: an external one distinctly striated radially, a broad median vacuolar zone, and a narrow internal layer with indistinct radial striation. The whole medullary mass appears finely granular, but higher powers exhibit a fine frothy structure, particularly prominent in the outer zone. There is no radial arrangement of granules, and the differentiation of keel-shaped plasmic portions is wholly due to the thicker strands of protoplasm. Very delicate bridges connect the keel-shaped portions. This structure is obscured in the median zone by the recurrence of simple or composite vacuoles. These inclose hyaline spherules containing concentrically arranged spherical concretions, probably composed of carbonate of lime.

The nucleus is roundish, and bordered by a double-contoured membrane. It appears to be almost homogeneous, but higher powers demonstrate the presence of a narrow-meshed framework. The proper chromatin substance is limited to 15–20 roundish angular nucleoli, round which the nuclear network is usually looser, so that they appear to be surrounded by clear spaces. They are, however, connected by fine threads to the framework. They stain very unequally.

Artificial Development in Actinosphærium.*—Prof. A. Gruber calls attention to a neglected observation by K. Brandt, which appeared in an inaugural dissertation—one of the best places for hiding observations—in 1877. "This division may be brought about artificially by cutting up the

* Zool. Anzeig., x. pp. 346–7.

animal into any number of pieces. Each of these, as Eichhorn has already observed, becomes a complete animal in a few hours. Greef has carried artificial multiplication very much further. He divided a single example into twenty to thirty fragments which soon sent out rounded pseudopodia, became differentiated into ecto- and endosarc, and finally completely resembled young individuals which had been produced naturally. But this change was effected in those fragments only which contained at least one nucleus; those without nuclei, or isolated nuclei died down. A uni-nuclear individual represents a simple naked cell which contains all the essential constituents of the Actinosphærium-body, and is capable of further development and of growth into a multicellular organism." Prof. Gruber points out that this observation confirms the experiments of Nussbaum and himself, and he takes the opportunity of remarking that in what appears to be an *Actinophrys*, he has lately observed apparently complete and active individuals which had no nucleus. A more or less long existence without a nucleus is therefore possible, but he believes that new formations never arise unless one is present.

Researches on Lower Organisms.* — M. P. A. Dangeard gives an account of a new species of *Heterophrys*, *H. dispersa*, which appears to be intermediate between the Nuclearia and the Heliozoa chlamydophora. It has often a green colour from feeding on substances which contain chlorophyll. Division, which has never before been seen in this genus, is very simple, ruptures being gradually effected along a broken line; encystation has also been observed. This new form differs from *H. varians* only by having a single nucleus.

The author has made a study of *Actinophrys Sol* and thinks that it shows distinctly the affinities of the Heliozoa with *Vampyrella*, *Nuclearia*, and *Heterophrys*.

After treating of *Pseudospora*, the author forms a new genus *Barbetia* for *Pseudospora volvocis* Cnk.; its systematic position is near *Heteromita*. Among the *Vampyrellæ* we find the description of a new species, *V. Euglenæ*; it varies from 5 or 6 μ to 25 or 30 μ in length, its form is irregular, but most often spherical, and as a rule only one specimen is found on a *Euglena*.

The author justifies the inclusion of all the forms just mentioned in the animal kingdom, judging that the presence of cellulose in *Vampyrella* and *Pseudospora* cannot outbalance the evidence afforded by the mode of nutrition, of locomotion, of reproduction, and of encystation.

Structure of Gregarines.†—Herr Z. v. Roboz describes the structure and history of a new Gregarine of an orange colour which he found at Villefranche in *Salpa bicaudata*, and names *Gregarina flava*. In conjugation the united mass measured over 2.5 mm. The solitary young forms, the conjugated pair, and the spore-forming cysts are described. The three divisions of the body (epimerite, protomerite, and deutomerite) are regarded as distinctly separate chambers. The movements are described and referred to a cortical muscular layer, consisting of longitudinal and transverse fibres which the author was able to isolate. The cuticle is penetrated by fine pores. The partitions between the different parts are formed by a continuation inwards of the cuticle, and not from Schneider's sarcocyte. The sarcocyte and entocyte were readily distinguishable, the latter containing the yellow oil-globules which gave the animal its colour.

* Ann. Sci. Nat.—Bot., iv. (1886) pp. 241-75 (2 pls.).

† Math. u. Naturw. Ber. aus Ungarn, iv. (1886) pp. 146-7.

Karyokinetic changes in the nucleus were observed. The division of the nucleolus, the formation of nuclear asters, the complete fusion of the conjugating individual, the expulsion of polar elements, and the formation of a new nucleus, which undergoes the subsequent division, are described in the original Hungarian paper.

Spore-formation in Gregarines.*—M. L. F. Henneguy reports the results of his application of modern technical methods to the elucidation of spore-formation in *Monocystis agilis* of the earthworm. It has been observed by Lieberkühn, for instance, that the spores may arise in different ways. Sometimes the cyst becomes covered with small clear vesicles which develop into pseudo-navicellæ; sometimes the contents segment like an ovum; sometimes the mass divides into a number of smaller masses, each of which becomes covered with spores. It is also known that the spores inclose a nucleus, and divide into several falciform nucleated elements surrounding a central residual core—the *noyau de reliquat*. A. Schneider has further described the repeated division of the nucleus and the distribution of the results throughout the protoplasm.

M. Henneguy's results corroborate those of Schneider, of which the author was unaware when he began his researches. By means of sections, &c., the following points have been demonstrated. (1) First of all, vacuoles appear in the large nucleolus; this breaks up into fragments; and a true karyokinetic division of the nucleus occurs. (2) If the contents of the cyst do not also divide, and the nuclei continue to multiply by division, they migrate to the surface, and there become surrounded by a little protoplasm. They do not all move outwards, however, to form a surface layer. A certain number remain at the centre, and there degenerate. (3) When the contents of the cyst divide into a few large masses, the same formation of spores is exhibited. The nuclei of each mass multiply by karyokinesis, and move to the surface.

M. Henneguy never observed the third mode of spore-formation described by Lieberkühn, where the whole cyst segments into spores. A central core is always to be seen at a given stage. The above facts apply to the macrospores, but within the microspore cysts the same processes were observed. The latter divide into a larger number of masses than the macrospore cysts. The author noted the presence of at least two distinct species—*Monocystis agilis* and *M. magna*. In some cases *M. agilis* was alone present, and with it were associated only microspore cysts.

Both macro- and microspores inclose a large nucleus with a chromatic network. The nucleus divides by karyokinesis, and as in the case of the cysts the equatorial plate and the "pectiniform" figure were observed. Each daughter nucleus retires to an opposite pole and there undergoes two successive divisions. The results move to the centre and become surrounded by protoplasm, forming eight units round the residual core of Schneider. The general occurrence of indirect division is thus once more demonstrated.

Revision of the Microsporidia.†—M. R. Moniez has some notes preparatory to revision of the Microsporidia. He describes a species, *Nosema helminthorum*, which lives in unarméd *Tæniæ*; the same or a closely allied form has been seen in *Ascaris mystax*. *Nosema anomala* is probably wrongly placed among the Microsporidia, as its spores are very small, have no suture, or geminate vesicles. The species found by Vlacovich in *Coluber carbonarius* is called *Nosema heteroica*. In *Cyclops* two species—*N. parva*

* CR. Soc. Biol., 1887, 4 pp.

† Comptes Rendus, civ. (1887) pp. 1312-4

and *N. virgula*—are found. From the group of the Microsporidia it appears to be necessary to remove *Amœbidium* and *Botellus*; *Lecaniascus polymorphus*, which is an Ascomycete; the parasite found by M. Balbiani in *Tortrix viridiana*; and, lastly, the organisms found by Leydig in the bee, which have been wrongly compared to *Closterium lunula*.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.*

(1) Cell-structure and Protoplasm.

Structure of the Nucleus.†—According to Herr E. Zacharias, the cell-nucleus of both plants and animals is composed of two distinct substances, plastin and nuclein. After treatment with artificial gastric juice, there remain in the cells, in addition to other substances, two others undissolved, readily distinguished from one another by their micro-chemical properties.

One of these, nuclein, occurs exclusively in those elements of the nucleus which form, during division, the colourable filament-loops. In consequence of the nuclein which they contain, these portions retain, on treatment with gastric juice or hydrochloric acid, a sharply defined, peculiarly shining appearance. During the action of the gastric juice, numerous drops of an oily appearance are excreted from the cell-protoplasm, which render the form less clear. If these drops are removed by washing with alcohol or ether, and examined in dilute hydrochloric acid, it is seen that the bodies of the peculiar shining appearance described exist only in the nucleus. The other substance, plastin, is an essential constituent of the entire protoplasmic cell-contents, including the nucleus and chromatophores. Gastric juice or dilute acids do not cause in it the characteristic appearance of nuclein. Bodies which contain plastin but no nuclein appear pale and swollen after treatment with these reagents, so that the difference between the two is usually seen after remaining in them for a time. Plastin also differs from nuclein in its behaviour towards other swelling or dissolving reagents; it does not swell in preparations treated with gastric juice on addition of a 10 per cent. solution of sodium chloride, and does not disappear, like nuclein, on treatment with a mixture of 4 parts (in vol.) of the concentrated hydrochloric acid of commerce and 3 parts of water. Plastin is, however, dissolved, after some time, by pure concentrated hydrochloric acid. It dissolves less easily in alkalis than nuclein, and by this means the latter can be removed, while the former remains behind unchanged.

Nuclein possesses the property of absorbing eagerly certain pigments, especially methyl-green, which was demonstrated by the author in sections of the root of *Phajus* and of *Tradescantia*. Zacharias's nuclein corresponds to the "soluble nuclein" of Miescher, his plastin to the plastin of Reinke and the "difficultly soluble nuclein" of Miescher.

The author confirms the observations of Schmitz, Strasburger, and Zalewski, of the existence of a cell-nucleus in the Saccharomycetes; but

* This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents; (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

† Bot. Ztg., xlv. (1887) pp. 282-8, 297-304, 313-9, 329-37, 345-56, 361-72, 377-88 (1 pl.).

disputes the assertion of Schmitz, Strasburger, and Tangl that the nucleus is wanting in the Phycobromaceæ. The presence of a nucleus was demonstrated in the cells of *Tolypothrix ægagropila* and *Oscillaria* sp. (in the former it can be seen even in the living plant), while the cell-protoplasm was found to be destitute of any substances exhibiting the reactions of nuclein.

The nucleins obtained from the yolk-spheres of animal ova differ in their reaction from those of the nuclei of vegetable cells. They were obtained from the frog, from *Scyllium canicula*, and from the hen. These agree in their properties with the nuclein obtained from milk, and differ from those now under consideration in not containing the elements of nitrogenous bases, such as guanine, hypoxanthine, &c. In the vegetable kingdom structures comparable to the yolk-spheres of animals have hitherto been found only in the ovum-cells of Gymnosperms; the author has found them in *Pinus sylvestris*.

In the resting condition the cell-nucleus consists of a matrix in which the framework of the nucleus and the nucleoli are imbedded; the former is distinguished by containing nuclein; the latter consist of albumen and plastin. If the albumen is removed from the nucleus by digestion, and the nuclein dissolved in soda, a network remains behind consisting of plastin. On the chemical nature of the matrix the author was unable to come to any definite conclusions.

As to the processes which take place during the division of the nucleus, the author combats the statement of Strasburger of the intrusion of the cell-protoplasm into the substance of the nucleus. Pollen mother-cells of *Hemerocallis fulva* in the first stages of division before the disappearance of the nucleolus, preserved in alcohol, showed after treatment with hydrochloric acid very clearly the matrix of the nucleus; and this matrix does not consist of cell-protoplasm, since it does not leave behind any residue of plastin when treated with gastric juice. The same is the case also with the spindle-fibres, which are stated by Strasburger to consist of cytohyaloplasm.

The author then discusses the changes which take place in the material constitution of the nucleus and nucleoli during division.

The nuclei of male sexual cells—those of the spermatozoa of animals and of cryptogams, and the generative nuclei of the pollen of Gymnosperms and Angiosperms—all exhibit essentially similar properties; they contain a larger quantity of nuclein than the nuclei of vegetative cells, and either smaller nucleoli or none at all.

The nuclei of the male and female sexual cells differ materially in their properties in the case of ferns (*Pteris serrulata*). The nucleus of the male cell contains no nucleoli, and apparently consists of a homogeneous mass composed essentially of nuclein. The nucleus of the female cell, on the other hand, encloses large nucleoli and no nuclein, but a network or framework exhibiting the reactions of plastin. The same is the case in Muscinæ, and, to a less extent, in Gymnosperms. In the latter a similarity is exhibited on the one hand between the nuclei of the canal-cells and the spermatozooids, and, on the other hand, between those of the ovum-cell and the vegetative nucleus of the pollen-tube. In Angiosperms the difference between the nuclei of the male and female cells is less striking than in the lower plants. In animals the same difference is presented between the nucleus of the ovum and that of the spermatozoid before impregnation as in the case of ferns and Muscinæ. In both animals and plants the nucleus of the male cell undergoes changes after its absorption into the female cell, resulting in a close approximation to the nucleus of the latter.

Functions of the Nucleus.*—In reference to the prevalent theory that all the vital properties of the cell are derived from the nucleus, Herr G. Klebs has made a number of observations on living cells of *Zygnema* plasmolysed by the action of a 16 per cent. solution of sugar. One effect of the plasmolysis is to cause the contracted cell-contents to divide mechanically into two halves, each including one of the two chlorophyll-bodies, while the whole of the nucleus is contained in one of the two halves. If the cultivation of such a plasmolysed *Zygnema*-filament is continued, it is seen that the two halves of each cell exhibit very different phenomena. The protoplasmic mass which contains the nucleus surrounds itself with a new cell-wall, and the single chlorophyll-body divides into two, between which is the nucleus. The half-cell soon begins to grow, and becomes a complete normal cell. The half-cells destitute of nuclei retain their vitality in some cases for as long a period as six weeks, during which time respiration and metastasis must necessarily go on, and starch is produced even more abundantly than in the portions which contain nuclei. They have, however, no power of developing a new cell-wall, and the same was the case in other examples observed, as *Spirogyra* and *Cedogonium*. That this power is dependent on the presence of a nucleus was shown by instances in which the two halves were not completely separated, but remained connected by a narrow isthmus, when both halves became enclosed in new cell-walls. The power of increasing in length goes also along with that of developing a new cell-wall. Similar results were obtained with *Funaria hygrometrica*.

The author concludes that the power of a cell to develop a cell-wall, and that of increasing in length, are essentially connected with the presence of a nucleus, while the properties of assimilation and respiration are derived from some other constituent of the cell.

(2) Other Cell-contents.

Proteids of the Seeds of *Abrus precatorius*.†—Mr. S. Martin states that the proteids of the seeds of *Abrus*, the Indian liquorice, are important physiologically, because they have been shown to be possessed of poisonous properties. The method of extraction used was based on the supposition that the proteids present in *Abrus* were similar to those in other seeds, consisting chiefly of the globulin and albumose classes. The finely ground seeds were shaken first of all with chloroform to remove the red cuticle which sinks in this liquid, so that the yellow kernel-powder could be easily removed, and obtained in the dry state by allowing the chloroform to evaporate. The powder obtained was then extracted with 15 per cent. sodium chloride solution for twenty-four hours, and the mixture filtered. The yellowish filtrate was distinctly acid, and gave a copious precipitate on boiling. The proteids were separated from this filtrate in two ways.

(1) Saturation with neutral ammonium sulphate and shaking for four hours throws down all the proteids in solution. (2) Saturation with sodium chloride and shaking for many hours gives only a scanty precipitate, which becomes copious on adding a large excess of glacial acetic acid. The properties of the globulin are that it is insoluble in distilled water, but readily soluble in 10 to 15 per cent. sodium chloride or magnesium sulphate solution. It is completely precipitated from solution by saturation with sodium chloride after slightly acidifying. The albumose is soluble in cold or boiling distilled water. It is not precipitated from

* Biol. Centralbl., vii. (1887) pp. 161-8, and Ber. Deutsch. Bot. Gesell., v. (1887) pp. 181-3.

† Proc. Roy. Soc. Lond., xlii. (1887) pp. 331-4.

solution by saturation with sodium chloride, unless a large excess of glacial acetic or phosphoric acid be added.

The author concludes by saying that there are, therefore, two proteids in the seeds of *Abrus precatorius*, a vegetable paraglobulin and an α -phytalbumose.

Cholin in Seedlings.*—Herr E. Schulze records the presence of this nitrogenous base in seedlings of lupin and gourd; this was determined by analysis of the double salt of gold and platinum.

Crystalloids in Stylidium and Æschynanthus.†—Herr C. Raunkiaer finds crystalloids in the epidermal cells of the under-side of the corollalobes of *Stylidium adustum*, and in the epidermal cells, especially of the leaves, of several species of *Æschynanthus*. They occur in the form of rhombic discs, 1-4 in each nucleus. They dissolve very rapidly on addition of water or alcohol, but, as the author thinks, not from solubility in the reagent, but from the access of the acid cell-sap.

Occurrence and Function of Tannin in Tissues.‡—Dr. M. Westermaier has investigated the conditions of the formation of tannin in a number of both herbaceous and woody plants (*Impatiens parviflora*, *Poterium Sanguisorba*, *Alchemilla vulgaris*, *Mespilus germanica*, *Quercus pedunculata*, &c.). He considers its formation to be distinctly dependent on illumination; in etiolated leaves and leaf-stalks it may even be altogether wanting. The tannin increases in the assimilating cells in the light; its increase and decrease appear to depend to a large extent on the same conditions as the increase and decrease of chlorophyll.

True Nature of Starch Cellulose.§—Herr Griessmayer has undertaken an investigation to ascertain the true nature of the coating said to surround the true grains of starch (granulose). Meyer considers this coating not to consist of a compound present in the unaltered granule, but to be the result of change of the starch. The coatings can be obtained by the following method: 1000 grains of potato starch are allowed to remain for 100 days in 6 litres of 12 per cent. hydrochloric acid; the coatings are then separated and filtered off, and washed with water; when dried they weigh about 300 grains, and when boiled in water they dissolve almost entirely; there remains, however, a small portion of cellulose tissue, fat, &c.; from the solution, cold causes the dissolved compound to separate, forming spherocrystals of amyloextrin.

(4) Structure of Tissues.

Differentiation of Epidermal Cells.||—Herr E. Heinricher observes that in some plants belonging to the Cruciferae some of the epidermal cells are from 10 to 20 or even 100 times larger than the adjacent cells. These large cells may be either solitary or associated in groups. This occurs in the stem as well as the leaves; in *Halophila pilosa* they attain a length of 8 mm. The object of these large cells appears to be to serve as a storage of water; they are found especially in species growing in very dry situations; where they are present, even cut shoots remain a long time without withering.

* Zeitschr. f. Physiol. Chem., xi. p. 365. See Naturforscher, xx. (1887) p. 261.

† Bot. Tidsskr., xvi. (1887) pp. 41-5. See Bot. Centralbl., xxx. (1887) p. 236.

‡ SB. K. Preuss. Akad. Wiss. Berlin, ix. (1887) pp. 127-44 (1 pl.).

§ Bied. Centr., 1887, pp. 190-2. See Journ. Chem. Soc. Lond., 1887—Abstr., p. 686. Cf. this Journal, ante, p. 256.

|| MT. Naturw. Ver. Steiermark, 1886, 29 pp. and 1 pl. See Bot. Centralbl., xxx. (1887) p. 305.

Network of Cells surrounding the Endoderm in the Roots of Cruciferae.*—M. P. van Tieghem states that he has already shown that a great number of the Coniferae, more particularly Cupressineae and Taxineae, have the cells of the cortical portion of the young root in contact with the endoderm strengthened by ligneous thickenings. An anatomical and physiological arrangement similar to this has been described by Woronin as occurring in the cabbage, and the author has recently studied a number of Cruciferae; the results of his investigations are detailed.

A series of transverse and longitudinal sections were made of the root of *Sinapis alba*, before the formation of secondary tissue; these were stained with fuchsin. All the cells of the last cortical layer but one were exactly superposed to those of the endoderm, and the cells of the ante-penultimate layer were provided towards the middle of their radial and transverse faces with a strong thickening band, which was stained red by the reagent. From each band a series of lesser bands spread towards the interior. The author states that a network of cells surrounding the endoderm occurs in *Cheiranthus*, *Alyssum*, *Koniga*, *Farselia*, *Berteroa*, *Vesicaria*, *Cochlearia*, *Malcolmia*, *Sisymbrium*, *Brassica*, &c.; while in *Matthiola*, *Nasturtium*, *Barbarea*, *Arabis*, *Turritis*, *Hesperis*, *Erysimum*, *Camelina*, *Diplotaxis*, *Iberis*, &c., this arrangement has not been found to occur.

Cortical Fibrovascular Bundles in Lecythideae and Barringtonieae.†—In some genera belonging to these orders Prof. M. M. Hartog finds a complete system of cortical bundles external to the pericycle, anastomosing with the leaf-traces at the nodes. They have often a complete circle of exogenous wood without pith, and a crescent of phloem on the outer side; they are all but concentric.

Passage of Fibrovascular Bundles from the Branch to the Leaf.‡—Dr. C. Acqua, agreeing generally with the observations of Petit,§ distinguishes 13 types of arrangement and distribution in the passage of the fibrovascular bundles from the branch to the leaf, dependent on the number of distinct cords of bundles which enter the leaf, the degree to which these cords unite or anastomose, and other points. Without attaching too much importance to the structure of the leaf-stalk, this may yet, in many cases, be usefully observed for systematic purposes. In all cases observed, where the bundles enter the leaf in a single cord or arc, the leaf itself was simple.

Second Primary Wood of the Root.||—M. P. van Tieghem states that it is well known that the primary wood of the root consists of a certain number of radiating woody bundles developed centripetally, alternating with a like number of liber-bundles, so that secondary wood, when it is produced, consists of vascular tangential bundles developed centrifugally, superposed internally to the liber-bundles. It is admitted that all the primary wood of the root is contained in the centripetally developed bundles, but it does not follow, as is usually supposed, that all the secondary wood is contained in the centrifugally developed bundles. It certainly is so in a great number of plants; but in many others the arrangement is different. The object of this paper is to explain the structure of the latter.

The author designates the centripetally formed vascular bundles alternating with the liber-bundles, as *protoxylem*, and the centrifugally formed

* Bull. Soc. Bot. France, xxxiv. (1887) pp. 125-30.

† Rep. Brit. Assoc. Birmingham Meeting, 1886, p. 706.

‡ Malpighia, i. (1887) pp. 277-82.

§ See this Journal, ante, p. 264.

|| Bull. Soc. Bot. France, xxxiv. (1887) pp. 101-5.

vascular bundles superposed to the liber-bundles, as *metaxylem*. In the same manner a *metaphloem*, as contrasted with the *protophloem*, is formed contemporaneously with the metaxylem. He sums up his conclusions as follows:—In the primary structure of the root two types may be distinguished: (1) the monoxyle type, where the wood remains in the condition of protoxylem; and (2) the diploxylic type, where the protoxylem is followed by metaxylem. Where there is any secondary wood, its first vessels are placed opposite the last vessels of the metaxylem, which it continues in a centrifugal direction.

Formation of the Annual Ring and Growth in Thickness.*—For the purpose of throwing light on the difference in structure between the spring and the autumn wood in the annual ring of dicotyledonous woody plants, Herr A. Wieler has investigated the corresponding phenomenon in a large number of annual plants, and in the annual stems of perennial plants. He finds that in many of these a true annual ring is formed, and very probably in all when the climatic conditions are favourable. This is evidently the case in *Helianthus annuus* and *Ricinus communis*; and here he believes he was able to demonstrate that the formation of the ring is dependent entirely on differences in the supply of nutriment at different periods of the year.

Autumnal Fall of Leaves.†—Prof. W. Hillhouse proposes to call the layer of cells formed by renewed cell-division in the basal plane of the leaf-stalk, the formation of which causes the dissociation of the leaf, the *absciss-layer*. It is readily recognized by the new dividing-walls formed across the cellular tissue of the base of the leaf-stalk, and by the large quantity of protoplasm contained in the cells, usually accompanied by numerous small starch-grains. It is usually formed very shortly before the fall of the leaf, which is due to the increased turgidity of the cells of the absciss-layer, owing to their osmotic activity; they become strongly rounded, their adhesion diminishing at the same time. The soft elements of the vascular bundles are either pinched, or else cell-division takes place in them also; the lignified elements also undergo changes.

In leaves about to fall starch is always found in the sieve-tubes, mainly collected in cloudy granular-looking masses in the neighbourhood of the sieve-plates; this starch stains brown or reddish-brown with iodine. The nucleus, or at least the chromatin, appears to be left behind in the empty cells of fallen leaves, the nucleus tending towards disintegration, as distinguished from fragmentation or direct division. In the leaves of ever-greens examined, starch was also absent in winter, being transferred to the stem, while the tannin, on the other hand, remained behind, as is also the case in fallen leaves.

(5) Structure of Organs.

Seedlings of *Salicornia herbacea*.‡—Herr A. Winkler describes the structure of the seedlings of this plant, which possess the peculiarity of the two cotyledons being coalescent at their base, the cone of growth lying in a depression between them.

Formation of Rootlets and position of Buds in the Binary Roots of Phanerogams.§—M. P. van Tieghem states that the place of formation of rootlets in the pericycle of the mother-root is fixed by two rules, and not

* Pringsheim's Jahrb. f. Wiss. Bot., xviii. (1887) pp. 70-132 (2 pls.).

† Rep. Brit. Assoc. Birmingham Meeting, 1886, pp. 700-1.

‡ Verhandl. Bot. Ver. Prov. Brandenburg, xxviii. (1887) pp. 32-3.

§ Bull. Soc. Bot. France, xxxiv. (1887) pp. 11-6 and 39-44.

by one only, as has been the theory up to the present time. Firstly, when the mother-root possesses more than two woody bundles, and secondly, when the mother-root only possesses two woody bundles. Whenever the structure is binary, the root, whether it be terminal or lateral, or whether it belong to the primary or secondary or any other order, forms its rootlets in the pericycle opposite the intervals which separate the two woody bundles from the two liber-bundles.

It is a well-known fact that certain Phanerogams produce regularly buds upon their roots and upon the hypocotyledonary portion of their stems. These are normal buds, and must not be confused with adventitious buds. Firstly, with regard to the buds which appear shortly after germination on the lower portion of the hypocotyledonary stem. In order to form one of these buds, three epidermal cells situated at the extremity of the ray which passes between the two liber-bundles and the two woody bundles, divide first by radial, then by tangential and oblique septa, and produce a mass of small cells which forms a projection on the external surface. The bud then is entirely of epidermal origin. The radical buds, on the other hand, are produced at the base of the primary rootlets, and are enclosed within the cortex of the terminal root; their actual production takes place in the same manner as has been described in the case of hypocotyledonary buds.

Both radical and hypocotyledonary buds are, therefore, distributed in the root in the same manner as rootlets, and in the stem in the same manner as lateral roots. Frequently they are formed at the same depth as rootlets and lateral roots, that is to say, in the pericycle, and are to the same extent endogenous; but sometimes, as in *Linaria*, they are formed in the epidermis, and are exogenous.

Origin of Rootlets and Lateral Roots in Rubiaceæ, Violaceæ, and Apocynaceæ.*—MM. P. van Tieghem and H. Douliot state that in Rubiaceæ the terminal root is binary, and consequently produces its rootlets opposite the intervals which separate the two woody bundles from the two liber-bundles. In Violaceæ the terminal binary root (*Viola nana*, *V. odorata*), or a lateral binary root (*V. canadensis*), produces its rootlets in four series in its pericycle. In Apocynaceæ the rootlets are formed opposite the woody bundles. In the violet (*V. nana*) and in Rubiaceæ the lateral roots which are produced after germination in the hypocotyledonary stem proceed from the pericycle; in fact, their origin is the same as that of the rootlets.

The authors then describe in detail the formation of the lateral roots in *Asperula taurina*. They conclude the paper by stating that, seeing that the formation of rootlets and early lateral roots in Leguminosæ, Cucurbitaceæ, Rubiaceæ, Violaceæ, and Apocynaceæ is found to take place in the usual manner, one can see that only one type of formation for these exists among Dicotyledons.

In a previous paper† the authors have shown the same to be the case among Monocotyledons; and it is well known that in Gymnosperms the rootlets are formed in the pericycle of the mother-root. In Vascular Cryptogams it is the endoderm of the root which gives rise to rootlets and lateral roots; but in this case the endoderm is the external layer of the pericycle. The general conclusion of the authors is that in all vascular plants the rootlets and the early lateral roots are formed in the pericycle of the generating member.

* Bull. Soc. Bot. France, xxxiv. (1887) pp. 150-4,†

† See this Journal, ante, p. 262.

Formation of Tubers.*—Herr H. Vöchting has investigated the cause of the formation of underground tubers, which he believes to be primarily the absence of light, and secondarily an abundant supply of water. Tubers are, however, frequently formed above ground, and even sometimes on parts which are fully illuminated. Their production is then due to internal causes perpetuated by heredity. Tubers may be either annual as in the potato and artichoke, or perennial as in species of *Begonia*.

Positively geotropic Shoots of *Cordyline australis*.†—Prof. F. O. Bower found that when stems of this plant assumed an oblique or horizontal position by reason of the weight of the head of leaves, axillary shoots were formed on the lower side pointing directly downwards; the apex of these shoots remaining covered with scale-leaves. We have here a special adaptation for the mechanical and physiological support of a weakly axis.

Structure and Development of the Suckers of *Melampyrum pratense*.‡—M. Leclerc du Sablon states that the primary cause of the formation of the suckers of *Melampyrum pratense* seems to be contact with a body containing nutritive matter of use to the plant. A small protuberance is formed proceeding from the cortex; the cells composing the two layers of the cortical parenchyma elongate radially, and are then divided by septa in different directions. The cells of the endoderm then elongate radially and divide in the same manner, and finally the cells of the pericycle are divided by tangential septa. The sucker is composed of a mass of homogeneous parenchyma, the cells of which are filled with protoplasm which is more or less dense.

Ascidia of *Cephalotus follicularis*.§—M. P. Maury states that the leaves of *Cephalotus follicularis* are of two kinds; some have an entire limb, and are oval; the others are ascidia, and have a cylindrical petiole. A transverse section of the petiole made about a centimetre from the point of attachment of the ascidia shows seven fibrovascular bundles disposed in a circle. Near the point of attachment the circle of bundles is divided into two arcs: one above, composed of three bundles; the other lower, composed of four. The cells in the epidermis of the ascidia are more or less sinuous. Stomata are present; the guard-cells on the side of the opening are provided with cellulose thickenings.

The author divides the interior of the ascidia into five divisions:—(1) The interior face of the operculum, (2) the neck, (3) the middle portion, (4) the lateral coloured patches, and (5) the lower portion.

Histology of Vine-leaves.||—In reference to the current statement that the spores of *Peronospora viticola* put out filaments which find their way into the tissue of vine-leaves through the stomata, Sig. P. Pichi has examined the leaves of several species of *Vitis* and *Cissus*, and finds uniformly an entire absence of stomata from the upper surface, while they are present in large numbers on the under surface and in smaller numbers on the leaf-stalk. The cells of the upper epidermis of the leaf differ from those of the under epidermis chiefly in the folding of their walls.

Structure and Development of Palm-leaves.¶—Herr A. Naumann has undertaken an examination of the history of development of the pinnate or otherwise compound leaves in a number of species of palm:—*Phoenix dacty-*

* Vöchting, H., Ueb. d. Bildung der Knollen, 55 pp., 5 pls., and 5 figs., Cassel, 1887. See Bot. Centralbl., xxx. (1887) p. 339.

† Rep. Brit. Assoc. Birmingham Meeting, 1886, p. 699.

‡ Bull. Soc. Bot. France, xxiv. (1887) pp. 154-8.

§ Ibid., pp. 164-8.

|| Atti Soc. Tosc. Sci. Nat., 1887, Proc. Verb., pp. 197-8.

¶ Flora, lxx. (1887) pp. 193-202, 209-18, 227-42, 250-7 (2 pls.).

lifera and several other species, *Dæmonerops melanochæte*, *Hyophorbe indica*, *Seaforthia elegans*, *Bactris setosa*, *Chamædorea elegans* and two other species, *Chamerops humilis*, *Livistona australis*, *Rhapis flabelliformis*, and in *Carludovica palmata* (Pandanaceæ).

The leaf of all palms originates on the cone of growth as a circular wall of unequal height, not completely embracing the cone at its lower part, but which becomes closed by subsequent growth, and forms at this region the origin of the sheath. At the higher portion of the cushion, which subsequently becomes the rachis, a lamina is formed at an early period, which has the form of a cap, and which has the same origin in ferns with both pinnate and digitate leaves. The rudiment of the lamina is visible in a flat cushion which runs obliquely down the rudiment of the rachis. In the species with pinnate leaves the rudiments of the pinnae are unsymmetrical on the two sides of the rachis. At a very early period in all families of palms, furrows make their appearance on both the upper and under side of the leaves, vertical in the digitate, horizontal in the pinnate species, which develop into fissures. In an early stage the lamina of all palm-leaves is therefore perfectly continuous; the alternation of these furrows with cushions gives an appearance which has been erroneously ascribed by previous writers to a folding of the lamina.

The variations in different species are described in detail with regard to the veneration, the mode of separation of the segments of the lamina, and the unfolding of the leaf. The so-called "ligula" occurs in all palms with digitate leaves, but varies greatly in size. It is not present in the digitate leaves of *Carludovica*.

Stipular Sheath of Polygonum.*—Herr A. Y. Grevillius describes the structure of the stipular sheath or ocrea in several species of *Polygonum*, some of terrestrial, some of aquatic habit, and suggests that its very unequal development in the different species is connected with their different biological conditions.

Turgidity of Petals.†—Prof. O. Beccari has noticed the existence of water in a state of strong tension in the cells of the thick petals of *Magnolia Yulan*, *Nerium Oleander*, and *Camellia japonica*, and in the leaves of *Rumex Lunaria*, shown by the appearance of a little cloud of vapour when the epidermis is removed.

Spike-like partial inflorescence of the Rhynchosporæ.‡—According to Herr L. Celakovsky, the Rhynchosporæ and Galnieæ differ from the other sections of the Cyperaceæ in the divisions of the inflorescence not being true spikes, but spike-like cymes consisting in most instances of only two or three flowers.

Zygomorphy of Flowers.§—Prof. F. Delpino describes the various degrees of zygomorphy which occur in different flowers, and classifies the forms of flowers as follows in relation to their mode of pollination.

Omnilateral actinomorphic are among the least specialized flowers, and are adapted to the visits of insects of various kinds; such are those of *Ranunculus*, *Rosa*, *Potentilla*, *Pæonia*, *Nymphæa*, &c. *Sexilateral actinomorphic* flowers, such as those of many species of *Lilium*, are specially adapted to the visits of Sphingidæ, while those which are *quinquelateral* and *actinomorphic*, such as *Aquilegia* and the Apocynaceæ and Asclepiadææ,

* Naturf. Studentsällsk. Upsala, Dec. 7, 1886. See Bot. Centralbl., xxx. (1887) pp. 254-5, 287-8, 333-5. Cf. this Journal, *ante*, p. 430.

† Malpighia, i. (1887) p. 420.

‡ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 148-52 (1 fig.).

§ Malpighia, i. (1887) pp. 245-62. Cf. this Journal, *ante*, p. 266.

are contrived for Apidæ and Lepidoptera with a longer or shorter proboscis. Of *trilateral actinomorphic* flowers an example occurs in *Iris*, with adaptation to the visits of the larger Apidæ, such as *Bombus*, &c., and the same is the case with the *bilateral* flowers of *Dicentra*, probably similar to the primitive type of the nearly allied Cruciferae.

Monocentric actinomorphic or *subzygomorphic* flowers are those with a longer or shorter tube, visibly adapted to insects furnished with a proboscis. *Lychnis dioica* and some species of *Clerodendron* may be cited as examples.

The very numerous *unilateral zygomorphic* flowers may be again classified, either according to the region of the visiting insect which becomes pollinated, as *nototribal*, *sternotribal*, and *pleurotribal*, or according to the class to which the visiting insect (or bird) belongs, as *melittophilous*, *sphingophilous*, or *ornithophilous*. Nototribal melittophilous flowers include the Labiatae, Scrophulariaceae, Bignoniaceae, &c.; nototribal ornithophilous flowers are exclusively exotic. Among the sternotribal melittophilous are included the greater part of Papilionaceae, *Viola*, *Rhododendron*, &c.; *Amaryllis formosissima* is sternotribal and ornithophilous; *Lilium longiflorum* and *Funckia* sternotribal and sphingophilous. Zygomorphic pleurotribal flowers are almost entirely melittophilous, such as Polygaleae, some Papilionaceae, &c.

In those families in which zygomorphy is most strongly pronounced, there is scarcely a single instance of anemophilous flowers.

Origin of Zygomorphic Flowers.*—Herr W. O. Focke suggests a probable origin of zygomorphic flowers from a comparison with those whorls of leaves, such as those of *Catalpa syriacæfolia*, where one leaf in the whorl is more fully developed than the others, viz. the one which is most exposed to air and light. He calls attention to two specially marked types of zygomorphy, viz.:—(1) The Leguminosæ-type, which appears to have originated in a curvature of the style causing the concave side to be directed upwards, and which may be the simple result of light-irritation; the petals are here quite distinct or only slightly coherent at the base; to this type belong, besides the Leguminosæ, some Amaryllideae, Chrysobalanæ, and Geraniaceae. (2) The Labiatae-type, where the corolla is distinctly gamopetalous, often two-lipped, and the stamens have a tendency to become didynamous; to this type belong the Lobeliaceae, Caprifoliaceae, Bignoniaceae, Scrophulariaceae, and Labiatae, with a modified form in the Compositae. Besides these are several other less clearly marked types, the origin of which is not so clear.

Conduction of Irritation in irritable stigmas.†—Mr. F. W. Oliver has investigated the mode of conduction of the irritation in the stigmas of *Martynia lutea* and *proboscidea* and *Mimulus luteus* and *cardinalis*, and believes it to be due to the continuity of the protoplasm from cell to cell, which he was able to demonstrate by Gardiner's method of sulphuric acid and Hoffmann's blue.

In both the genera mentioned, the tissue of the stigma consists of two lamellae which are sensitive to contact on the inner side only. The internal tissue of the lamellae is composed of 15 to 20 layers of excessively thin-walled prismatic cells with a great development of intercellular spaces. Between the upper and lower epidermis of the lamellae runs a simple axile vascular bundle of spirally thickened tracheids. The bundles from the two stigmas do not unite before they reach the ovary. The irritability is

* Oesterr. Bot. Zeitschr., xxxvii. (1887) pp. 123–6, 157–61. Cf. this Journal, *ante*, p. 266.

† Ber. Deutsch. Bot. Gesell., v. (1887) pp. 162–9 (2 figs.).

confined to several layers of the prismatic cells of the inner side of the lamellæ, and it is here that the continuity of the protoplasm from cell to cell was determined. A conduction of the irritation from one lamella of the stigma to the other takes place in the two species of *Martynia*, and in *Mimulus cardinalis*, but not in *M. luteus*. That the conduction does not take place through the vascular bundle was demonstrated by the fact that it is not affected by cutting the bundle.

Nectary of *Galanthus nivalis*.*—Prof. F. Delpino points out that Sprengel and H. Müller are in error in regarding the green streaks on the inner surface of the petals of the snowdrop as a nectary. They secrete no nectariferous fluid of any kind, but are simply "Saftmaale," or guides to the pollinating insect to find its way to the true nectary, which is a minute circular green pit or foveola on the summit of the ovary surrounding the styles.

Nectary and Aril of *Jeffersonia*.† —Dr. S. Calloni describes the nectaries in *Jeffersonia diphylla* (Berberidaceæ) as swellings at the base of each petal, which are closed glands formed by differentiation of the parenchyma in the course of the development of the petals. The torn aril with which the ripe seeds are provided, and no trace of which is to be seen in their early stage, is a true arillus resulting from a differentiation of the parenchyma of the funicle.

"Crazy" pollen of the Bell-wort.‡ —Mr. B. D. Halsted states that the pollen of the large flowered bell-wort (*Uvularia grandiflora* Sm.) is of good size, smooth coated, nearly colourless, and in many ways well adapted for use in laboratory work with students. In the experiments conducted by the author, one of the culture slides lost a large part of the nourishing sugar solution by absorption into pieces of surrounding blotting paper, and the pollen-grains upon the under surface of the suspended glass cover produced tubes of very strange abnormal forms. Some germinated from the side, others from the end, while others still sent out tubes from both side and end. In some cases the pollen-grain looked as if it had undergone a process similar to that of the popping open of a grain of Indian corn. In others there was an amoeba-like mass projecting from one side of the grain, having not less than a dozen arms extending in as many directions.

Anatomical studies on *Mayaca*.§ —M. V. A. Poulsen states that the root of *Mayaca* Aubl. is adventitious, and comes from the lower part of the trunk. The intermediate zone of the cortex incloses a system of aeriferous chambers. The cells of the endoderm are uniformly lignified, as are also those of the pericambium successively as they advance in age. The aeriferous chambers in the trunk are very large, and present characteristic development with specialized cells in the septa. The leaves are small, and, as in *Lycopodium*, the epidermis on the two surfaces is similar, and does not contain chlorophyll.

The original paper (in Danish), is illustrated by four plates.

* Malpighia, i. (1887) pp. 354-8.

† Ibid., pp. 311-6 (1 pl.).

‡ Bot. Gazette, xii. (1887) pp. 139-40.

§ Overs. K. Danske Vid. Selsk., 1886, pp. 85-100 (5 pls.), French Résumé, pp. xxi.-iv.

B. Physiology.*

(1) Reproduction and Germination.

Fertilization of *Epipactis latifolia*.†—Mr. A. D. Webster states that all or nearly all his observations tend to show (1) that *Epipactis latifolia* is very imperfectly fertilized; (2) that, although visited by insects, cross-fertilization seldom takes place; and (3) that self-fertilization by the pollen falling spontaneously on the stigma is not uncommon.

That the plant is very imperfectly fertilized is evident from the small quantity of seed produced. Nineteen plants growing in consecutive order in one wood were examined, and out of a possible 492 capsules only 38 produced seed. That, although visited by insects, cross-fertilization seldom takes place, is proved by the following observations. Amongst insects of sufficient size to remove the pollinia that have been seen visiting the flowers of this *Epipactis*, may be mentioned the red-tailed humble bee and our common wasp, the latter, however, but very rarely. The author has observed the above-mentioned bee enter several flowers on two different plants without in any case removing the pollinia; also a red-tailed humble bee visiting sixteen flowers on a spike without removing any of the pollinia.

Self-fertilization by the pollen falling spontaneously on the stigma is not uncommon. The author has observed that the pollen-masses in a few days, or perhaps a week, after the flowers open, become swollen, or the particles of pollen disunited so as to protrude slightly beyond the sharp upper edge of the stigma. The pollen becomes friable, and before the plant withers, either spontaneously or by the action of the wind, falls on the stigma and other parts of the flower.

Influence of Ozone on Germination.‡—Herr A. Vogel states that strongly ozonized air seems to have no harmful influence on the germination of seeds. Milk and meat can be kept for a longer time in ozonized air without change than in ordinary air.

(2) Nutrition and Growth.

Transpiration and Assimilation in Leaves treated with Milk of Lime.§—In view of the mode of treatment of vines for the destruction of the *Peronospora*, the question is of some importance whether the functions of transpiration and assimilation are checked or prevented by the application to the leaves of milk of lime. From a series of experiments on the leaves of the horse-chestnut, cherry, and vine, Dr. G. Cuboni has come to the conclusion that it has no injurious effect.

(3) Movement.

Part taken by the Medullary Rays in the Movement of Water.||—Dr. J. M. Janse has confirmed by experiment Godlewski's theory¶ that the living parenchymatous elements of wood take an active part in the movement of the transpiration-current. The objections made by various authors to the soundness of this hypothesis he regards as unimportant; and states that experiments show that the part taken by the medullary rays is connected with certain conditions:—a definite arrangement of the elements of the wood, greater power of resistance to filtration, and the unilateral action

* This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth; (3) Movement; and (4) Chemical Changes (including Respiration and Fermentation).

† Bot. Gazette, xii. (1887) pp. 104-9.

‡ Bied. Centr., 1887, p. 142. See Journ. Chem. Soc. Lond., 1887, Abstr., p. 516.

§ Malpighia, i. (1887) pp. 295-310 (1 pl.).

|| Pringsheim's Jahrb. f. Wiss. Bot., xviii. (1887) pp. 1-69 (1 pl.).

¶ See this Journal, 1886, p. 1016.

of the cells belonging to the rays—all of which are fulfilled in the wood. Although Dr. Janse's observations were made chiefly on Conifers, he does not think the results would have been essentially different had the wood of Dicotyledons been the subject of investigation.

(4) Chemical Changes (including Respiration and Fermentation).

Supposed Reduction of Nitrates by Barley and Maize. *—M. A. Jorissen gives the results of some experiments which he performed with a view of finding out whether nitrates are reduced by barley or maize. The grains were first placed for half an hour in a dilute solution of mercuric chloride; they were then washed in boiling water, and afterwards placed in boiling distilled water for twenty-four hours. The author then caused them to germinate in tubes previously sterilized, and when the rootlets were about a centimetre long they were placed in a 1 per cent. solution of potassium nitrate. At the end of twenty-four and forty-eight hours the liquid was examined for nitrous acid. No reduction was found to have taken place. This result is contrary to that obtained by Laurent and Schönbein. The author attributes the reduction which took place in their experiments to the presence of living organisms in the culture liquids.

Liberation of Nitrogen from its compounds, and acquisition of atmospheric Nitrogen by Plants.†—The conclusions arrived at by Mr. W. O. Atwater are the following:—(1) During the growth of peas, nitrogen is in most cases acquired from the air; but in some few cases where the conditions of growth are abnormal, there is either no gain in nitrogen or there is a slight loss. This loss is to be explained by the evolution of free nitrogen from the nutriment, or from the seeds and plants during germination and growth; it is probably a constant, and may cause considerable error in all the experiments. (2) Boussingault has found the amount of atmospheric nitrogen absorbed to be very small; but in his experiments the plants were not normally nourished, and probably, therefore, were less able to resist the action of denitrifying ferments or to absorb nitrogen from the air. (3) Numerous experiments have shown a slight gain or loss of nitrogen during germination and growth, but the failure of an experiment to show the acquisition of nitrogen from the air proves the non-assimilation of atmospheric nitrogen only on condition of the further proof that no nitrogen was liberated. (4) The liberation of nitrogen appears to be due in some cases, if not in all, to ferments. (5) The way in which the nitrogen is acquired is still a matter of doubt. (6) The experiments of Boussingault, and of Lawes, Gilbert, and Pugh, which have given the strongest evidence against the fixation of free nitrogen by plants, are possibly affected by the loss of nitrogen already referred to, by the exclusion of the action of electricity and of microbes, and by the fact that the plants were also for the most part poorly fed. (7) In the author's experiments ignited sea-sand was used for growing the plants in, and hence it is probable that the plants themselves and not the soil are factors in the acquisition of atmospheric nitrogen. (8) Lawes, Gilbert, and Warington have shown the great probability that leguminous plants, which appear to possess in a high degree the power of obtaining nitrogen from natural sources, induce the action of nitrifying ferments by which the inert nitrogen of the soil is made available. It is equally conceivable that the same plants and others may favour the action of nitrogen-fixing micro-organisms.

* Bull. Acad. R. Sci. Belg., xiii. (1887) pp. 445-8.

† Amer. Chem. Journ., viii. (1886) pp. 398-420. See Journ. Chem. Soc. Lond., 1887—Abstr., p. 515. Cf. this Journal, *ante*, p. 270.

7. General.

Autumnal Changes in Maple Leaves.*—Messrs. W. K. Martin and S. B. Thomas give the results of certain investigations conducted in the botanical laboratory of Wabash College. The structure of the normal green maple leaf consists of the ordinary epidermal layer above and below, a single cell in depth, a single layer of rather elongated palissade-cells, and usually about three layers of spongy parenchyma, more closely packed than usual. The chlorophyll bodies are small, and thickly and evenly distributed throughout the mesophyll cells.

The first indication of the approach of autumnal changes is the withdrawal of the contents of the mesophyll-cells. The protoplasm seems to dispose of much of its substance in the manufacture of cellulose, and the chlorophyll-bodies are seen both to disintegrate and to blend together in large masses. In leaves which have become brown, a greater amount of cell-contents remains than in the red, the chlorophyll-bodies do not mass together so much, and the cell-sap is a dirty brown. In red leaves the cell-contents are even more reduced, some cells being almost empty, the remaining contents are mostly collected in masses of considerable size, and are often surrounded by a pellicle of cellulose. The cell-sap is coloured by the characteristic red colouring matter, erythrophyll. In yellow leaves the cell-contents are much like those of the red, but the cell-sap is colourless, and the chlorophyll-masses are stained yellow by xanthophyll.

Physiological Rôle of Vine Leaves.†—Herr H. Müller states that a large number of leaf-bearing shoots should be sacrificed during the ripening of the fruit. These leaves require a large quantity of sugar for their development and for the support of their respiration. In removing the old leaves during the ripening of the fruit, too great a loss of assimilating tissues need not be feared, because the old leaves have only feeble assimilating power, and are moreover in the shadow of the upper leaves. If two shoots are cut off and placed in darkness until all the starch has disappeared, then one of these simply placed in water, and the other injected with water under pressure, the latter will form starch much more abundantly than the former. The transformation of starch into sugar is similarly affected.

Influence of soil on the vegetation on the summits of the Alps.‡—M. J. Vallot states that the most interesting localities to study the influence of soil on the vegetation of the Alps are those where, in the midst of a uniform region, one finds a patch of soil of a different character. The Aiguilles Rouges which arise over Chamounix, opposite Mont Blanc, are formed of crystalline schist. On the other side, separated by a deep valley, rises the Buet, where the crystalline schist is covered by triassic and jurassic strata. At the Belvédère, the highest point of the Aiguilles Rouges, a small portion of sedimentary earth remains, and it is interesting to contrast the vegetation of the summit with that of the surrounding district.

The author then gives three lists of plants. One for the mica schist on the summit of the Belvédère, another for the calcareous schist of the Belvédère, and a third for the Buet.

The following plants are found only on the mica schist :—*Draba fladnizensis*, *Sempervivum montanum*, *Oxyria digyna*, *Carex curcula*, &c.; while *Ranunculus glacialis*, *Arabis alpina*, *Alsine verna*, *Campanula cenisia*, *Linaria alpina*, &c., are found on the calcareous, but not on the mica schist of the Belvédère.

* Bot. Gazette, xii. (1887) pp. 78-81.

† Ann. Agronom., xiii. p. 140. Cf. Journ. Chem. Soc. Lond., 1887, Abstr., p. 685.

‡ Bull. Soc. Bot. France, xxxiv. (1887) pp. 25-9.

Gummosis.*—Observations made by Dr. L. Savastano on *Acacia arabica*, *Phoenix dactylifera*, *Eucalyptus globulus*, *E. Sideroxylon*, *E. amygdalina*, *E. hemiphloia*, and *Fraxinus Ornus*, confirm the conclusion previously arrived at that this condition is comparatively rare in plants grown north of their proper zone of cultivation; and similar observations on the Amygdaleæ, Aurantiaceæ, vine, olive, *Quercus*, and *Acer*, show that any given species subject to gummosis is more liable to it in the southern than in the northern portion of its zone of cultivation.

Anæsthesia and Poisoning of Plants.†—Dr. F. Tassi records the results of about 100 experiments on the effect of a large number of anæsthetics and poisons on different plants. Among the general conclusions at which he has arrived is the existence of a property belonging to vegetable protoplasm analogous to that which in animals is called contractility, irritability, &c. Of the substances which are fatal to animals, some are poisonous, others anæsthetic, and others innocuous to plants. Among the latter are curare, and the poison of the viper and of the cobra. He observes also that the state of inertia or rigidity of flowers is often accompanied by a change of colour.

Humboldtia laurifolia as a myrmecophilous plant.‡—Prof. F. O. Bower states that the ants enter this plant through an opening formed by rupture of the superficial tissues, due apparently to pressure from within; they thus gain access to and hollow out the pith which had previously begun to decay. They are probably supplied with food from the numerous glands on the leaves. He could find no evidence that the symbiosis is of any advantage to the plant.

B. CRYPTOGAMIA.

Symbiosis of a Bacterium and Alga.§—Prof. A. Tomaschek records a singular instance of symbiosis in a slimy growth found on the walls of a greenhouse, which he found to consist of a Schizomycete in the zooglœa-form agreeing most nearly with *Bacillus megaterium*. A dirty violet or chocolate-brown colour was imparted to the mass by larger or smaller islands of a green alga (chlorophyllous protophyte), *Glœocapsa polydermatica*, imbedded in it. He regards the connection as an example, not of parasitism, but of true commensalism brought about by the needs of the bacterium for oxygen.

Cryptogamia Vascularia.

Rabenhorst's Cryptogamic Flora of Germany (Vascular Cryptogams).—The most recently published parts of this work (Parts 8–10), by Dr. C. Luerksen, complete the account of the Polypodiaceæ, and comprise also descriptions of the German species of Osmundaceæ, Ophioglossaceæ, and Rhizocarpeæ, and the commencement of a general description of Equisetaceæ. Every species, as well as the more important varieties, are illustrated by beautiful woodcuts, the descriptions and the lists of localities are very full, and nothing is omitted to make the work as full and accurate in every particular as could be desired.

Muscineæ.

Leaves of Mosses.||—Sig. G. Arcangeli points out that a useful character for discriminating species of moss can be drawn from the fact that in some

* Nuov. Giorn. Bot. Ital., xix. (1887) pp. 101–3.

† Ibid., pp. 29–104.

‡ Rep. Brit. Assoc. Birmingham Meeting, 1886, p. 699.

§ Oesterr. Bot. Zeitschr., xxxvii. (1887) pp. 190–2.

|| Atti Soc. Tosc. Sci. Nat., v. (1887) pp. 241–3.

forms the nervation of the leaves ends in a small projecting point or tooth, and in addition to this presents another small tooth pointing downwards below the apical tooth. This is the case in *Rhyncostegium striatum*, *R. rusciforme*, *Brachythecium salebrosum*, *B. velutinum*, *B. albicans*, and *B. reflexum*.

Analogous variations in Sphagnaceæ.*—M. C. Jensen states that in no other genus of mosses is the tendency of the individual species to vary more marked than in *Sphagnum*. It is not always possible to recognize the cause of these variations. Water appears to exercise the chief influence, then light or shade, and in some cases the temperature of the soil. The organs of the plant liable to variation are, firstly, the leaves, and then the branches, whether sterile or fructiferous. If the plant grows entirely in water, all the parts become larger and longer. These variations the author designates by the term *formæ immersæ*. Under the direct influence of the sun's rays the plants become more compact (*formæ compactæ et strictæ*). If the plant grow in the shade, it becomes more robust, and the leaves squarrose, (*formæ squarrosulæ*). The author also designates certain variations as *formæ falcatæ*, *formæ homophyllæ*, and *formæ tenellæ*.

By taking various species of *Sphagnum*, and tabulating them under the above divisions, the variation of the species taken can be seen at a glance. Take, for instance, *Sphagnum acutifolium* Ehrh. This species is represented in all the divisions, but especially well in *formæ tenellæ* and *compactæ*. In the first could be cited var. *fusca* Sch., *tenuis* Braithw., *rubella* Wils., and *gracilis* Russ.; and in the latter, var. *arcta* Braithw., *congesta* Gravet, and *Schimperi* Warnst. A *forma homophylla* also occurs, which might readily be confounded with *S. molle* Sull. The form *stricta* is well represented by the vars. *stricta* and *strictiformis* Warnst.; the *formæ immersæ* are rarer; to this belong vars. *plumosa* Milde, and *immersa* Schleich., while var. *squarrosula* Warnst. represents the *formæ squarrosulæ*.

Algæ.

Classification of Algæ.†—Mr. A. W. Bennett proposes some modifications in the existing systems of the classification of Algæ (including the chlorophyllous Protophyta), in accordance with their affinities. Too little importance has, he considers, at present been attached to degeneration or retrogression, which may be exhibited in the partial or complete suppression of either the reproductive or the vegetative organs.

He traces all the various forms of vegetable life to three lines of descent, represented by three distinct kinds of cell-contents—colourless, blue-green, and pure green. The first appears to originate in the Bacteria or Schizomycetes, from which are derived the whole group of Fungi. The second primordial type consists of unicellular organisms, in which the cell-contents are composed of a pale watery blue-green endochrome diffused through the protoplasm, without distinct chlorophyll-grains, starch-grains, or nucleus, the Chroococcaceæ, the simplest form of the Phycochromaceæ or Cyanophyceæ, which attain their highest development in the Nostochineæ, including the Oscillariaceæ, Rivulariaceæ, Scytonemaceæ, and Nostocaceæ. To them are probably related the Diatomaceæ, which the author regards as a simple form of life, probably not nearly connected with the Conjugatæ.

The third series, or Chlorophyllophyceæ, is the only one which has developed into the higher forms of vegetable life. It is characterized from the outset by the cells possessing a nucleus, starch-grains, pure chlorophyll,

* Rev. Bryol., xiv. (1887) pp. 33-42.

† Journ. Linn. Soc. Lond.—Bot., xxiv. (1887) pp. 49-61.

and, in certain states, a true cell-wall of cellulose. The lowest family—the Protococcaceæ—exhibit further development in two directions, the perfection and differentiation of the individual cells, and the association of cells into colonies or cœnobes. The latter tendency leads to the Sorastree, Pandorineæ, and finally to the Volvocineæ. The further differentiation of the individual cell has advanced one stage in the Eremobieæ or Characiaceæ, from which are derived the Multinucleatæ, comprising the Siphonocladaceæ and Siphoneæ. The striving after a high development by the elaboration of a single cell culminates in *Vaucheria*, or in such forms as *Acetabularia*. Cell-division is already well displayed in the Confervoidæ isogamæ, including the Chroolepideæ, Ulotrichaceæ, Confervaceæ, and Pithophoraceæ. From them evolution appears to have taken place in three different lines:—(1) the Conjugatæ, including the Zygnemaceæ, Mesocarpeæ, and Desmidiæ, which evidently came to an abrupt conclusion; (2) the Phæosporeæ, which led, through the Cutleriaceæ and Dictyoteæ, to the Fucaceæ, the highest type of “oogamous” reproduction, consisting in the impregnation of a comparatively large oosphere by a number of minute antherozoids; the Syngeneticeæ being regarded as a retrogressive offshoot from the Phæosporeæ; and (3) the Confervoidæ heterogamæ, including the Sphæropleaceæ, Ectogoniaceæ, and Coleochætaceæ, from which latter family the Pediatree are probably derived by retrogression. The Coleochætaceæ lead up directly to the highest type of structure attained by Thallophytes, the Florideæ, from the highest form of which we have probably several retrogressive branches, viz. the Nemalieæ, the Lemnaceæ, and the Bangiaceæ; the author suggests that the Ulvaceæ may possibly be derived from the Bangiaceæ by further retrogression.

Cause of the Turbidity of Water.*—Dr. C. O. Harz describes a peculiar appearance in the water of the Schliersee, in Bavaria, commencing when it was covered by ice;—a dense turbidity, at first of a green or blue tinge, but becoming finally yellow-red or peach-coloured before finally disappearing. This was due to enormous quantities of a *Palmella*, probably *P. wærfornis*, which was attacked and finally completely destroyed by a peach-coloured micrococcus, *Clathrocystis roseo-persicina*. In addition were found also smaller quantities of *Beggiatoa alba*, *B. roseo-persicina*, *Chlorococcum gigas*, *C. botryoides*, *Conferca bombycina*, *Cylindrospermum macrospermum*, a *Raphidium*, *Scenedesmus acutus*, and *S. obtusus*; also several diatoms and *Oscillarias*.

Dissemination of Algæ by Fish.†—Further observations on this subject by Sig. A. Piccone confirm his previous conclusion as to the important part played by herbivorous fish in disseminating seaweeds by feeding upon them. The contents of the stomach and intestines of many species inhabiting the Gulf of Genoa were examined, and found to contain large quantities of different species of seaweeds, and very frequently the fertile portions. Far the most important agent in this process is *Box Salpa*, in which were found the remains of no fewer than fifty species of marine algæ. In the stomach and intestines of *Sargus Rondeletii* were found twenty-four species, and smaller quantities in *Sargus annularis*, *Pagellus Mormyrus*, *Labrax Lupus*, *Scomber Scombrus*, *Scorpena Porcus*, *Labrus* two species, and *Belone Acis*; while *Box Boops*, *Cantharus lineatus*, *Pagellus Acarne*, *P. erythrinus*, *Chrysophrys aurata*, *Dentex vulgaris*, *Xyphias gladius*, *Zeus faber*, *Scorpena*

* SB. Bot. Ver. München, Dec. 20, 1886. See Bot. Centralbl., xxx. (1887) pp. 286-7, 331-2.

† Nuov. Giorn. Bot. Ital., xix. (1887) pp. 5-29. Cf. this Journal, 1885, p. 843.

Scrofa, *Trigla Hirundo*, *Labrus* species, *Merluccius vulgaris*, and *Raia* species, showed no indications of phytophagy. A gasteropod, *Aplysia* species, was also found to feed on Algæ.

New Diatoms.*—From fossil marine deposits in Barbadoes, Dr. H. H. Chase and Mr. C. W. Walker describe the following new species:—*Triceratium Weissflogii*, *T. fractum*, *T. granulatum*, *T. caribæum*, *T. minutum*, and *Stephanopyxis pulcher*.

Fungi.

Proliferation in the Mycelium of Fungi.†—This phenomenon, which Herr P. Lindner defines as the bulging of the septum which divides two cells into one of the cells, and then growing into a filament inclosed in it, has been at present observed, among fungi, in *Saprolegnia*, *Chætomium*, and *Inzengæa*. Herr Lindner now describes its occurrence in several mould-fungi, including *Epicoccum purpurascens*, *Alternaria* species, and *Botrytis cinerea*. The phenomenon is especially observable in both the aerial hyphæ and in the mycelial filaments which grow within the substratum of *Epicoccum purpurascens*, a somewhat rare fungus, distinguished by its intensely purple-red mycelium, belonging probably to the Ascomycetes, but of which the conidial mode of reproduction only is at present known.

Saccharine Substances in the Phalloideæ.‡—Sig. F. Morini gives the following as the main results of his investigations on several species of fungi belonging to this group:—

The mature gleba of *Clathrus cancellatus* contains dextrose and a sugar which is probably mycose or trealose; it also exhibits a special gummy mucilage. In the gleba of *Phallus impudicus* the glucose consists chiefly of dextrose; levulose was in fact observed in much smaller quantities. In addition, a gummy substance is found in some abundance homologous to that in *C. cancellatus*. In the gleba of *Mutinus caninus*, the glucose is accompanied by a small quantity of a mucilaginous substance. The receptacles of *C. cancellatus*, and *P. impudicus* contain levulose and smaller quantities of dextrose and trealose; that of *M. caninus* glucose, and a very small quantity of trealose.

The glucoses of the gleba owe their origin chiefly to metamorphosis of the mucilaginous substance produced by a gelification of the membrane of the sporigenous hyphæ. The glycogen is mostly transformed into glucose, and this is the ordinary form in which the carbohydrates are transferred from one part to another in the course of development.

Tubercular Swellings on the Roots of Leguminosæ.§—Prof. H. Marshall Ward finds that the tubercles on the roots of the Leguminosæ are due to the action of a parasitic fungus. Not only has he produced the tubercles by infection from without, but he has also found the infecting agent, and repeatedly seen and figured the infecting hypha passing down inside a root-hair and across the cortex of the root into the young tubercle. Here the hyphal branches bud off yeast-like cells, which are extremely minute and numerous, and resemble bacteria at first sight; they differ in their mode of multiplying by budding. The action of the minute germ-like bodies causes the protoplasm of the cells of the root to assume plasmodium-like characters, and induces the flow of nutritive substances to these cells,

* Chase, H. H., and Walker, C. W., 'Notes on some new and rare Diatoms,' series ii., iii., 12 pp. and 3 pls., 1887.

† Ber. Deutsch. Bot. Gesell., v. (1887) pp. 153-61 (1 pl.).

‡ Malpighia, i. (1887) pp. 369-83.

§ Proc. Roy. Soc. Lond., xlii. (1887) p. 331. Cf. this Journal, *ante*, p. 610.

and hypertrophy results. On the decay of the tubercles the germ-like bodies pass into the soil (where they can always be found) and infect other roots; it is very probable they may be of extreme importance in agriculture.

Phosphorescent Fungus.*—Abbé J. Dulac has observed two tufts of *Agaricus olearius* very strongly phosphorescent, and was able to determine that the fungi were parasitic on the roots of *Poa pratensis*.

Mycelites ossifragus—a Fungus in Bone.†—Prof. W. Roux had his attention directed to striations in sections of a rib of *Rhytina stelleri*. These bands have parallel contours, and consist of a substance slightly more refractive than the surrounding osseous tissue; they became more obvious after the section had been treated with 5 per cent. nitric acid; and after treatment with iodine and sulphuric acid a blue coloration became apparent. The author gives a detailed account of his observations and experiments, and states that, on showing them to Prof. Hasse, the latter recognized the bands as having been seen by him in fossil vertebræ from various strata as low as triassic deposits.

On coming to the conclusion that he had to do with something not belonging to the osseous tissue itself, the animal kingdom was first thought of, but every suggestion was found to lead to difficulties; the *Leptothrix buccalis* and its influence in producing caries of the teeth was so far a happier suggestion, that it led to the vegetable kingdom being proposed for study; the canals in the bone agreed in thickness, form, and mode of branching with the lower plants; and fungi present, in their mycelial filaments, thick plexuses like those found in the bone; fungi are also known to force their hyphæ into organic substances. As the fungi are classified by the characters of their sporangia, attention was given to the special rounded structures in the bone which were seen to have the form, some of unripe, and some of ripe spores of the *Phycomycetes*; going further, they appear to present a resemblance to *Saprolegnia*; waiting for further discoveries to settle this question more definitely, the growth may be called *Mycelites ossifragus*.

Brief reference is made to the canals in the shells of Lamellibranchs and Gastropods, which Wedl supposed to be due to algæ, but Kölliker (who extended the observation to a number of other forms) to fungi; and to the observations of Duncan and Moseley on *Achlya*.

Peronospora umbelliferarum on the Vine.‡—By repeated experiments, Sig. P. Pichi has been able to obtain on the lower surface of leaves of the vine, infection from zoosporanges of this fungus obtained from *Ægopodium Podagraria*.

Propagation of Peronospora viticola by means of Oospores.§—M. E. Prillieux has attempted, together with M. Fréchou, to germinate the oospores of this *Peronospora*, and has found them generally emit well-developed tubes. Sometimes one of these tubes becomes directly fructiferous and bears conidia.

M. d'Arbois of Jubainville examined the leaves of the vine on the first appearance of conidiferous filaments, and noticed small brown spots which corresponded to the points where, on the other side, small particles of earth adhered. These spots gradually increased in size, and at the end of a month produced the fructification of *Peronospora*.

* Rev. Mycol., ix. (1887) pp. 12-3.

† Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 227-54 (1 pl.).

‡ Atti Soc. Tosc. Sci. Nat., v. (1887) pp. 258-9.

§ Bull. Soc. Bot. France, xxxiv. (1887) pp. 85-7.

The author concludes by stating that those vines in which the leaves touch the surface of the soil are attacked by the parasite first and with the greatest intensity.

Amblyosporium.*—In describing a new species, *Amblyosporium bicollum*, parasitic on *Lycoperdon gemmatum*, M. J. Costantin gives the following as the generic characters of *Amblyosporium* (Mucedinæ):—(1) The foot is very long, and supports a head formed of conidia, which differentiates itself from the summit towards the base of the filaments that attach themselves to the foot. (2) The capitula are successively of two different colours. (3) It is further characterized by its development on Hymenomycetes.

Celery-leaf Blight.†—Mr. B. T. Galloway states that this disease, due to the fungus *Cercospora Apii* Fres., annually destroys about one-half of the celery planted in Columbia. Frequent showers and heavy dews followed by hot sunshine favour the growth of the fungus. It usually appears about July 1st, and on the approach of cool weather, which usually comes on in September, the fungus gradually disappears. When fresh the conidia germinate readily (in three hours) by sending out a delicate colourless thread from each cell. So long as the celery leaves are kept dry but few of the conidia germinate, but if the leaves are frequently moistened, the fungus quickly destroys them. Celery protected from the direct rays of the sun, either by natural means, as planting under trees, or by screens made for the purpose, is rarely attacked by the parasite.

On September 26th, 1886, several healthy celery plants that were growing in the open air were lifted, and planted in the greenhouse. About one week later sowings of the conidia of *C. Apii* were made upon the leaves of several plants. Fifteen days later, the leaves where the sowings had been made showed pale-green pustules. Owing to the cool weather which came on about the time the pustules made their appearance, the fungus made no further progress, except several spots which showed the brownish hyphæ, but no conidia. The plants upon which no sowings had been made remained healthy. A form of *C. Apii* is quite common on *Pastinaca*, but is quite distinct from that on cultivated celery. Mr. Ellis suggests the name *Cercospora Pastinacæ* for the form on *Pastinaca*.

Cyphella.‡—From a careful examination of the structure and life-history of *C. endophila*, found on dead branches of *Phytolacca dioica* in the Neapolitan territory, Dr. O. Mattiolo separates the genus *Cyphella* entirely from *Cantharellus*, with which it had been supposed by Fries to be allied, and places it near to *Corticium* and *Thelephora*.

Parasitism of *Agaricus melleus*.§—A series of experiments made by Dr. L. Savastano on the nature of the parasitism of this fungus on a number of trees, leads him to the conclusion that it is not a primary cause of disease, as it does not attack healthy plants, but only such as are already in an unhealthy condition.

Fungi parasitic on *Camellia*.||—Sig. J. Passerini enumerates and describes the following new species of fungi parasitic on *Camellia japonica*, chiefly on the dry branches:—*Sphærulina Camelliæ*, *Phoma tenuis*, *P. tecta*, *P. ejiciens*, *P. Camelliæ*, *P. longicruris*, *Macrophoma Camelliæ*, *M. japonica*,

* Bull. Soc. Bot. France, xxxiv. (1887) pp. 30-3.

† Bot. Gazette, xii. (1887) pp. 66-7.

‡ Atti R. Accad. Sci. Torino, xxii. (1887) pp. 355-61 (1 pl.).

§ Nuov. Giorn. Bot. Ital., xix. (1887) pp. 97-100.

|| Rev. Mycol., ix. (1887) pp. 145-6.

Ascochyta minutissima, *Hendersonia Camelliae*, *Rhabdospora advena*, and *Pestalozzia Camelliae*.

Parasitism of Tuber.*—Dr. O. Mattiolo has established the fact that some rhizomorphs parasitic on roots perfectly resembling those known as mycorrhiza by Frank † and others, give rise, in circumstances not accurately defined, to receptacles of species of *Tuber*, especially to *T. excavatum* Vitt. and *T. lapideum* n. sp. In both these species are internal cavities formed by a depression of the peridium, and opening externally by an aperture. This winding cavity is clothed by a number of dark-brown filaments united lengthwise into bundles, identical with the rhizomorphs of many genera of fungi. These filaments were determined by the author to proceed indubitably from the pseudo-parenchyma of the peridium, the continuity of the hyphae being, however, lost with age. From the cavity in the receptacle these rhizomorphous hyphae extend in all directions, forming a mycorrhiza, in all respects resembling that found on the roots of Cupuliferae. The parasitism of the truffle on roots Dr. Mattiolo considers to be amply demonstrated.

Chaetomium.‡—The reproductive structure of this genus of Ascomycetes having been differently interpreted by different observers, the life-history has again been subjected to careful investigation by Herr F. Oltmanns. The species most fully worked out is *C. Kunzeanum*, grown on decoction of fruit. From the spore proceeds, as described by Zopf, a vesicle, from which spring the mycelial filaments spreading in all directions and branching abundantly in favourable nutrient solutions. The filaments are smooth or torulose according to the conditions of growth.

From the mycelium are developed undoubted ascogones, in which two spiral bands can be clearly distinguished; the coils may either be elevated above the pedicel or may embrace it; the pedicel is occasionally wanting, apparently an abnormal structure. In many cases the existence of a pollinodium can be distinctly made out, agreeing in essential points with that of *Eurotium*. The pollinodium appears always to spring from the pedicel of the carpogonium; but its presence is often very uncertain; and in other cases it is clearly wanting, always when the carpogonium is coiled round its own pedicel.

The envelope, in which the ascogone is eventually completely inclosed, originates from branches of the hyphae out of which the ascogone springs. The result is the production of a roundish ball with comparatively smooth surface, from which project the separate hairs characteristic of the genus; and the wall of the perithecium is then fully formed inclosing the archicarpus. The author never saw perithecia which did not inclose an ascogone; but several ascogones may be inclosed in a common envelope. The development of the perithecium may take place in four different ways, which, however, run into one another, viz.:—(1) The hyphae which constitute the envelope spring from immediately beneath the ascogone, as its pedicel; (2) Hyphae are formed from the entire pedicel which interweave to form the envelope; (3) The pedicel of the ascogone and the adjacent hyphae form numerous filaments; (4) The enveloping hyphae are formed in large numbers before the production of the ascogone, which is often pushed in at a much later period.

From careful longitudinal sections of perithecia, which are very difficult

* Atti R. Accad. Torino, xxii. (1887) pp. 464-72, and Malpighia, i. (1887) pp. 359-69 (1 pl.).

† See this Journal, 1886, p. 113.

‡ Bot. Ztg., xlv. (1887) pp. 193-200, 209-18, 225-33, 249-54, 265-71 (1 pl.). Cf. this Journal, 1882, p. 376.

to obtain, at various stages, it is seen that at a certain period the ascogone breaks up into a mass of cells. The wall of the perithecium becomes now differentiated into an outer brown layer and an inner layer, the cells of which continue to increase in size, and rhizoids are formed from the lower portion, distinguished by their brown colour and irregular curving. A cavity is now formed in the central group of cells, bounded by the cells formed out of the ascogone, the upper layers of which disappear, while the lower layers remain. The cells of the walls of the perithecium which bound the cavity elongate into tubes which are periphyses, and those which still remain of the ascogone-cells also elongate vertically into filaments, which constitute a cushion, and from the rods which form this cushion are developed the asci. There are no paraphyses. As the asci are developing, an opening is formed to the perithecium, before the ascospores are fully developed. The mode in which the ascospores escape from the asci is not certain, but the perithecium becomes gradually filled with them, fresh asci being constantly formed. The author regards the "nucleophyses" of Zopf as simply periphyses.

The life-history was also followed out of *C. bostrychodes*, *murorum*, *pannosum*, and *crispatum*, differing only in unimportant points from that of *C. Kunzeanum*.

Gonidia are freely formed in cultures which have exhausted their nutrient solution. They have no connection with the perithecia.

As regards its systematic position, the author considers *Chætomium* as most nearly allied to *Melanospora*.

Mycorrhiza.*—M. H. Lecomte states that he has found mycorrhiza on the roots of various trees, particularly the beech, chestnut, oak, and hazel. On the roots of the hazel conidia and two perithecia have been observed. The first perithecium, found in September, was only $35\ \mu$ in diameter; the second, observed in November, was nearly spherical, and had a diameter of $46\ \mu$. The perithecium was composed of pseudo-parenchyma. When pressed five brownish spores escaped. The spores were each formed of a thread of four cells, and resembled certain spores of *Perisporium*. Their length was $12\ \mu$. The conidia were borne by colourless filaments; some were terminal, and some inserted laterally on the filaments. The conidia were elongated, and composed of two cells. Their length was about $14\ \mu$.

The author states that it is not possible to actually determine the true affinities of this fungus, although in a great many of its characters it approaches the *Perisporiaceæ*.

New pathogenous species of Mucor.†—In addition to the only two pathogenous species of *Mucor* hitherto known, *M. rhizopodiformis* and *corymbifer*, Herr W. Lindt now describes two others, *M. pusillus* and *ramosus*. The former is distinguished by its very small size, the sporangiophore rarely exceeding 1 mm. in length. *M. ramosus* resembles *M. corymbifer*, but has larger spores. The infection-experiments were made on rabbits; a *Mucor*-mycosis resulting, altogether different from an *Aspergillus*-mycosis, and presenting the same pathological characters as that of the two species already known.

Fungous Diseases of Plants.‡—Mr. W. B. Grove finds that the *Eucharis* disease is due to the attacks of *Saccharomyces glutinis*, which attacks also

* Bull. Soc. Bot. France, xxxiv. (1887) pp. 38-9. Cf. this Journal, 1886, p. 113.

† Lindt, W., MT. ü. einige neue pathogene Schimmelpilze (1 pl.), Leipzig, 1886. See Bot. Ztg., xlv. (1887) p. 204.

‡ Rep. Brit. Assoc. Birmingham Meeting, 1886, p. 700.

other bulbs besides those of *Eucharis*. The fungus which occurs in the two forms of *Æcidium depauperans* and *Puccinia ægra*, is exceedingly destructive to cultivated species of *Viola*.

Tubercles on *Ruppia rostellata* and *Zannichellia polycarpa* produced by *Tetramyxa parasitica*.*—Dr. E. Hisinger has examined the structures produced by this Myxomycete. The cycle of development was fully followed out, including the formation of the tetraspores. The parasite attacks in the first place the youngest and tenderest tissues of the host, and the course of injury is very similar to that produced by *Plasmodiophora Brassicæ*.

Protophyta.

Oidium albicans.†—Dr. H. C. Plaut finds that this organism develops by sprouting and by the formation of mycelia from gonidia. The resting spores described by Grawitz and others he suspects to be merely conditions of involution, while the sporangium of Baginski is undoubtedly an involution form. The author next discusses *Monilia candida* Bon., growing on rotten wood. This, transferred to the mucosa of the crop of fowls and pigeons, was found to be indistinguishable from *Oidium albicans*.

Cultivations made from such material always retained the biological and physiological characteristics of the true *Oidium* cultures. The inference drawn is that *O. albicans* and *Monilia candida* Bon. are identical, and the author proposes that the former should be known as *Monilia candida*.

This organism is easily destroyed by sublimate solution, and is not transferable to the healthy mucous membrane of animals with a "strong constitution."

Heterocystous Nostocaceæ.‡—The concluding part of MM. Bornet and Flahault's exhaustive account of the heterocystous Nostocaceæ contained in the principal French herbaria is devoted to the tribes Sirospionaceæ and Scytonemaceæ. The former are characterized by the cells dividing in the direction of the length of the trichome, and by branches resulting from the development of one of the collateral cells formed by this division. The sheath may be either closed or continuous; only in *Mastigocoleus* do certain branches terminate in hairs. The heterocysts occupy the place of an entire cell when the trichome is formed of cells not divided longitudinally; otherwise at the expense of one of the peripheral collateral cells. Seventeen species are described in detail, belonging to five genera, growing in stagnant water or on damp rocks, several in thermal springs, only one in salt water. The genera *Mastigocoleus*, *Hapalosiphon*, *Stigonema* (including *Sirospion*), and *Capsosira* make up the subtribe Stigonemæ, distinguished by having a definite outline; the subtribe Nostochopsidæ, in which the sheaths coalesce externally into an amorphous gelatinous mass, comprises only the monotypic genus *Nostochopsis* from America and Sumatra.

In the Scytonemaceæ the trichomes never terminate in hairs, and the cells never divide longitudinally. The filaments are simple only in *Microchæte*; in the other genera branches emerge from the sheath either immediately below a heterocyst, or from the middle of an interval between two; the sheath is continuous, and frequently coloured; the heterocysts are intercalary or basilar, solitary or in rows. Seven genera are described,

* Meddel. Soc. pro Fauna et Flora Fennica, 1887, 8 pp. and 10 pls. See Rev. Mycol., ix. (1887) p. 168.

† Plaut, H. C., 'Neue Beiträge zur systematischen Stellung des Soorpilzes in der Botanik,' 32 pp., 12 figs., 8vo, Leipzig, 1887.

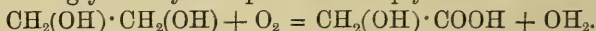
‡ Ann. Sci. Nat.—Bot., v. (1887) pp. 51-129. Cf. this Journal, ante, p. 449.

including forty species, of which only three are marine. In *Microchaete*, *Scytonema* (including *Petalonema*), *Hassallia*, and *Tolypothrix*, the trichomes are solitary in their sheaths; in *Desmonema*, *Hydrocoryne*, and *Diplocolon*, from two to six trichomes are frequently included in a common sheath.

Beggiatoa alba.*—Prof. W. Hillhouse finds this organism in the coccus form and in that of rodlets and spirals, and displaying swarming and even creeping movements like those of the *Oscillariaceæ*. It may be grown for laboratory purposes on fragments of (vulcanized) indiarubber tubing kept in water, on which it will usually appear spontaneously after the lapse of a few months.

Chemical Action of *Bacterium aceti*.†—Mr. A. J. Brown gives some further notes on the chemical action of *Bacterium aceti*. The oxidizing action of the pure ferment on mannitol has been described, showing that this carbohydrate is completely decomposed, and that a sugar (levulose) is the main product formed from it. As dulcitol is an isomerid of mannitol, it appeared interesting to ascertain if *B. aceti* had any action on it, more especially as, according to Carlet, dulcitol yields a $C_6H_{12}O_6$ sugar on oxidation with dilute nitric acid. In the several experiments made, however, not the least action of the ferment on the dissolved dulcitol could be detected.

Action of *B. aceti* on glycol.—The action of *B. aceti* on a 2 per cent. solution of the dihydric alcohol glycol was next studied. The solution was sterilized and inoculated with the ferment in the usual manner. At first the ferment grew freely, but the action was evidently over in five weeks' time. On opening the flask the solution was found to be slightly but distinctly acid; a portion was evaporated to a small bulk and filtered, and the absence proved of any acid giving an insoluble lime salt. The rest of the solution was boiled with calcic carbonate, filtered, and the lime salt so formed precipitated by excess of alcohol. The precipitate was dried, and a determination of the lime made. From the amount of lime present it seemed probable that this precipitate was glycollate of calcium, and a second experiment confirmed this opinion. The action of the ferment on glycol may be represented simply thus:—



Action of *B. aceti* on glycerol.—The action of *B. aceti* on a 5 per cent. solution of the trihydric alcohol glycerol was next tried. From the first the bacteria increased with remarkable freedom, and after the expiration of eleven weeks, when the flask was opened, there appeared to be a larger growth of the ferment, both in the liquid and as a deposit at the bottom, than had previously been observed in any other experiment with *B. aceti*. At the end of the experiment, titration of a portion of the solution showed that there was 0.114 per cent. acid present calculated as acetic acid. It appeared from the several experiments made that the action of *B. aceti* on glycerol is to decompose it into carbonic acid and water, the only other product of the action being a very small amount of an acid the nature of which is undetermined.

Action of *B. aceti* on erythrol.—Solutions of this tetrahydric alcohol in yeast-water, both with and without calcic carbonate, were submitted to the action of *B. aceti*; but although the ferment grew freely, no action on the erythrol could be detected. The fact that erythrol is not acted on by *B. aceti* is interesting, because this same substance is oxidized by platinum-black to erythric acid.

It will be noticed, therefore, that not only is *B. aceti* unable in some

* Rep. Brit. Assoc. Birmingham Meeting, 1886, p. 701.

† Journ. Chem. Soc. Lond., 1887—Trans., pp. 638-42.

cases to oxidize a compound which is oxidized by platinum-black, but also that in the action of the ferment and of platinum-black on the same compound, the products formed in these actions usually differ.

The author concludes by noting the action of the ferment on mannitol prepared from manna, and on the mannitol formed by the action of sodium amalgam on dextrose. He states that there can be little doubt that the two compounds are identical.

Cellulose formed by *Bacterium xylinum*.*—Mr. A. J. Brown has endeavoured to ascertain whether cellulose formed by the ferment from levulose would yield a dextro-rotatory sugar on treatment with sulphuric acid like ordinary cellulose, or whether a levo-rotatory sugar would be formed. In order to ascertain this, a membrane of the ferment was grown in a yeast-water solution of levulose prepared from pure inulin. The author concludes by stating that the cellulose formed from levulose by *B. xylinum* yields a dextro-rotatory sugar on hydrolysis in a similar manner to ordinary cellulose; and a way of converting a levo- into a dextro-rotatory sugar is thus shown.

Anaerobic culture of aerobic Bacteria.†—According to Prof. M. M. Hartog and Mr. A. P. Swan, *Bacillus subtilis* will germinate in appropriate nutritive solutions, and form its "Kahmhaut" and spores, when oxygen is excluded from the space not occupied by the liquid, and replaced by carbon dioxide. The lactic organism of Pasteur, usually aerobic, will also develop and grow in suitable solutions during or after alcoholic fermentation induced by *Saccharomyces*, after the oxygen must have been used up and replaced by carbon dioxide.

Chemical reaction for Cholera Bacteria.‡—Dr. O. Bujwid states that the addition of a 5–10 per cent. hydrochloric acid to a bouillon cultivation of comma bacilli produces, in a few minutes, often in a few seconds, a red-violet colour. The colour increases for half an hour, and in a bright light becomes brownish. The staining is more evident if the cultivation be still warm. The reaction does not take place in impure cultivations. With Finkler-Prior's comma bacilli a similar but more brownish stain takes place, but after a longer time. The reaction which may be effected with other mineral acids does not affect many other kinds of bacilli.

Changes induced in water by the development of Bacteria.§—Sig. T. Leone has already demonstrated that the number of micro-organisms in a typically pure water, such as the Maugfall, near Munich, although at first small, yet on standing gradually increases to a maximum, and afterwards rapidly decreases. The development of bacteria induces certain chemical changes in the water; thus the quantity of oxidizable organic matter gradually decreases, whilst the proportion of ammonia increases to a maximum, and then decreases owing to its oxidation into nitrites and nitrates; on this account, the time which elapses between the taking of a sample and its analysis is an important factor. The consequent changes are divisible roughly into two distinct periods: the first, in which the organic matter is decomposed with production of ammonia; and the second, in which this is subsequently oxidized. It is further shown, on the other hand, that certain micro-organisms seem to act as reducing agents, reconverting the nitrates

* Journ. Chem. Soc. Lond., 1887—Trans., p. 643.

† Rep. Brit. Assoc. Birmingham Meeting, 1886, p. 706.

‡ Zeitschr. f. Hygiene, ii. (1837) p. 52.

§ Gazzetta, xvi. pp. 505–11. See Journ. Chem. Soc. Lond., 1887—Abstr., p. 615.

into ammonia; and even the same organisms, according to the conditions, may either have an oxidising or a reducing function. In the first phase, when the nutritive matter is readily oxidizable and assimilated, the micro-organisms thrive at its expense, the process of nitrification being materially assisted by atmospheric oxygen; in the second phase, on the other hand, the necessary oxygen is derived from the nitrates; thus a change, seemingly of reduction, is induced.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Thury's Multiocular Microscope.—Prof. M. Thury has devised a Microscope (figs. 201 and 202) for enabling several observers to view the same object without having to change their seats. The following is a translation of the description which he sends us:—

“It is well known how tedious demonstrations with the ordinary Microscope are in consequence of the professor and his pupils having to continually change places. The Microscopes with two or three tubes, designed by M. Nachet (figs. 203 and 204) [and that of Prof. Harting,† fig. 205] obviate this inconvenience, but at the expense of a deterioration of the image, which is the more objectionable in consequence of its increasing rapidly with the power of the objective. This essential defect arises from the injurious influence of the edge of the prism, always imperfect, which occupies a diametral position relatively to the objective, disturbing a zone in the latter of constant size, which has therefore a greater influence on the image according as the objective has a smaller diameter.

It seemed to me that these inconveniences might be avoided, if in place of dividing the image between different observers it was received entire by a total-reflection prism, and by a movement of the prism passed successively to the different oculars of a Microscope with several tubes.

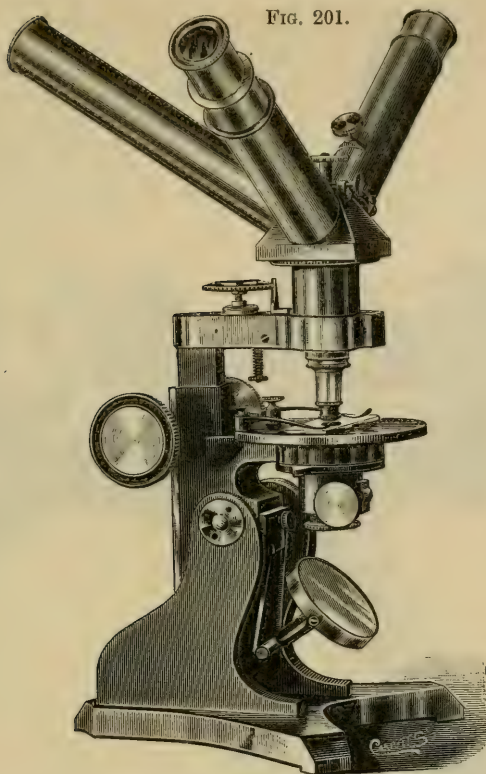
In consequence of the aberrations of colour and form which always take place in the case of prisms, the reflected image cannot be as perfect as the image obtained without it, but the difference is hardly appreciable. For instance, a Hartnack No. 9 objective which shows the beads of *Pleurosigma angulatum* with central light in the ordinary Microscope, shows them also, a little less distinct only, after reflection by the prism. A mirror of silvered glass would remedy this defect but at the expense of diminished permanence of the reflector.

The position of the prism P is shown in fig. 202. It is placed at a little distance behind the objective so as to diminish the effects of aberration, which are at their maximum when the prism is immediately behind the objective, as is necessarily the case when the image is multiplied in the manner hitherto adopted. The stage of the Microscope being horizontal and the optic axis of the objective consequently vertical, the prism is arranged to turn round a vertical axis situated in the prolongation of the

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photo-micrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Harting, P., *Das Mikroskop*, 1855, p. 780 (1 fig.).

FIG. 201.



axis of the objective. The prism is inclined on its axis of movement so as to reflect the light in a direction making an angle of 30° with the horizon.

There are two tubes each with an eye-piece inclined about 60° to the vertical, and which can be placed opposite each other in the same vertical plane or in two planes at right angles. If the Microscope is intended for three persons there is a middle tube with two lateral ones at right angles with it.

All the tubes except one have an arrangement for focusing by the eye-piece, so that each observer may adjust the instrument to his own sight once for all.

The possible defect of centering of the objectives, in consequence of which the image fails to occupy the same situation in the field of the different eyepieces, is remedied by allowing the inclination of the tubes to be

FIG. 202.

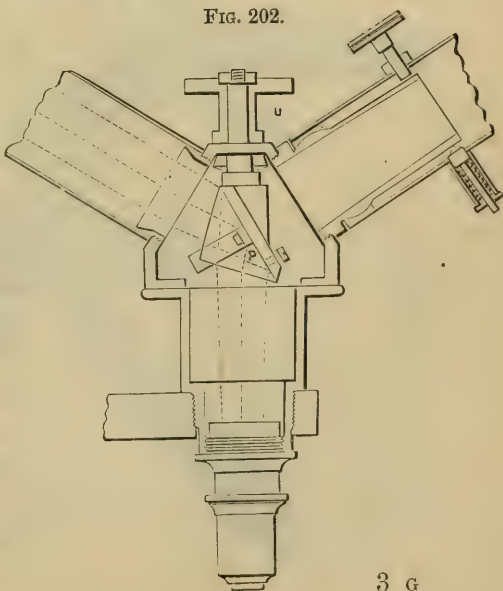
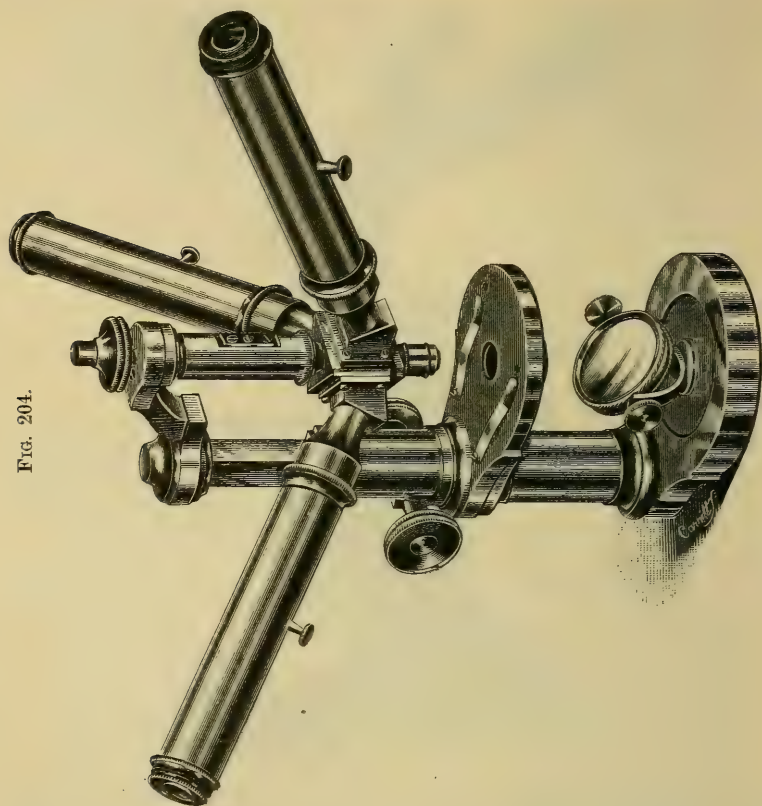
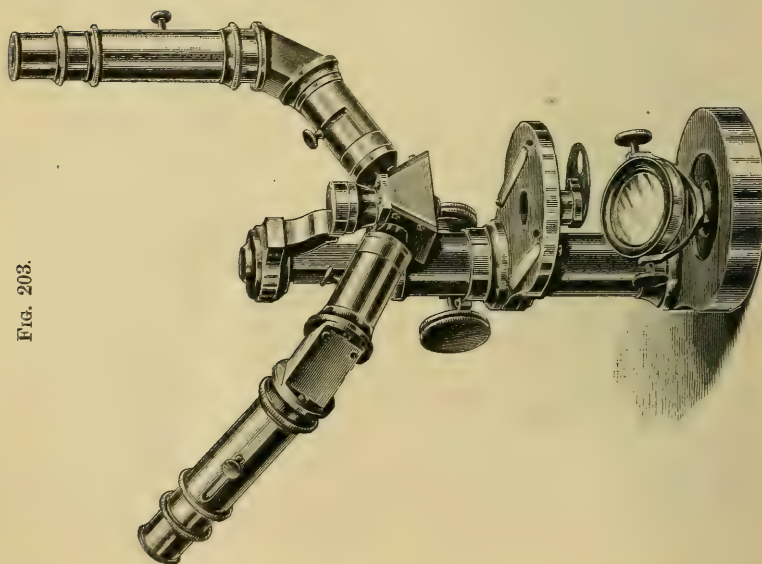


FIG. 204.



NACHET'S MICROSCOPE À TROIS CORPS.

FIG. 203.



NACHET'S MICROSCOPE À DEUX CORPS.

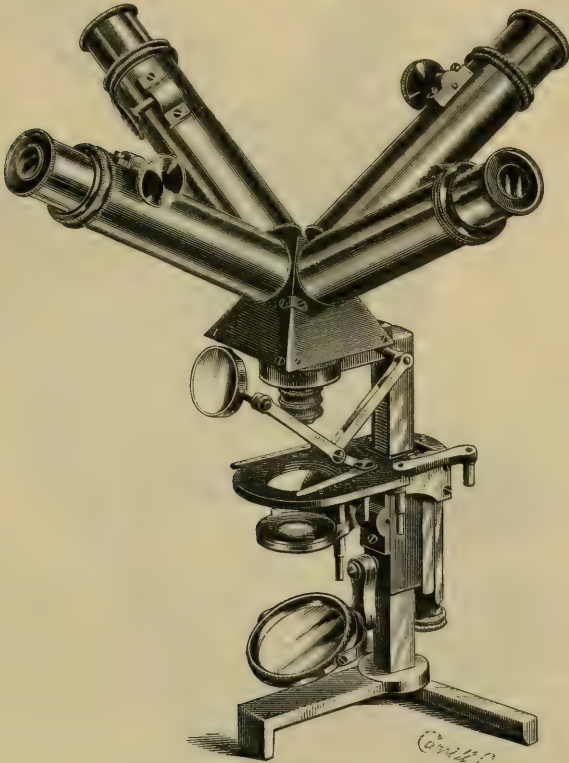
slightly varied, which makes the position of the images identical. There are also stops to limit at pleasure the movement of the prism.

By turning the prism by the milled head at U the image is transferred instantaneously from one tube to the other.

I hope that the new arrangement will render good service to the laboratories where microscopical anatomy is taught."

In some of the earlier forms of Stephenson's Binocular Microscope the upper prism box was made to rotate on the optic axis, carrying with it the

FIG. 205.



HARTING'S QUADRIOCULAR MICROSCOPE.

body-tubes, so that a circle of observers could view the object successively. Prof. Thury's plan, however, avoids the loss of time involved in swinging the tube round, and, what is more important, especially in the case of moving objects, in readjusting the focus for each observer.

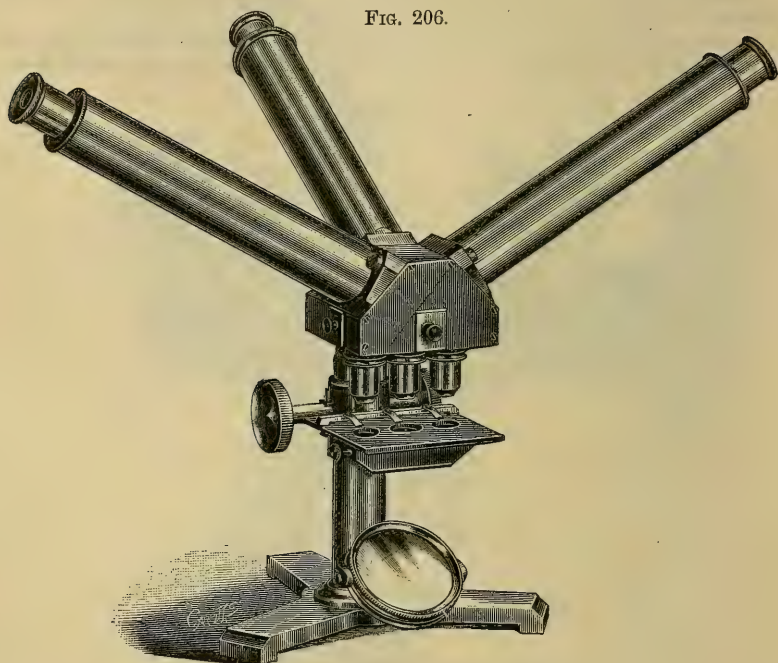
Ahrens's Triocular Microscope.—We cannot be sure that we fully appreciate the rationale of this instrument made by Mr. C. D. Ahrens (fig. 206), but it seems none the less necessary to notice it here if we are to maintain our original intention of recording such designs as have been considered sufficiently practical to be actually manufactured. Moreover, all classes of scientific bodies—zoologists, botanists, horticulturists, medical men, &c.—exhibit and record the abnormalities of their respective branches.

The Microscope consists, as will be seen, of a stand with three bodies

and three objectives, over which are three prisms, which deflect the rays at angles of about 45° .

In order to make use of one mirror only, Mr. Ahrens fits beneath the stage the arrangement of prisms shown in fig. 207, consisting of one equi-

FIG. 206.



lateral and two rhomboidal prisms. These divide the rays from the mirror, sending part into each of the side prisms whence they are reflected into the two lateral objectives.

A Microscope with several bodies and *one* objective so that the *same* object may be viewed by several observers (as in the forms above described) has obvious uses, while a Microscope with two bodies and *two* objectives is

FIG. 207.



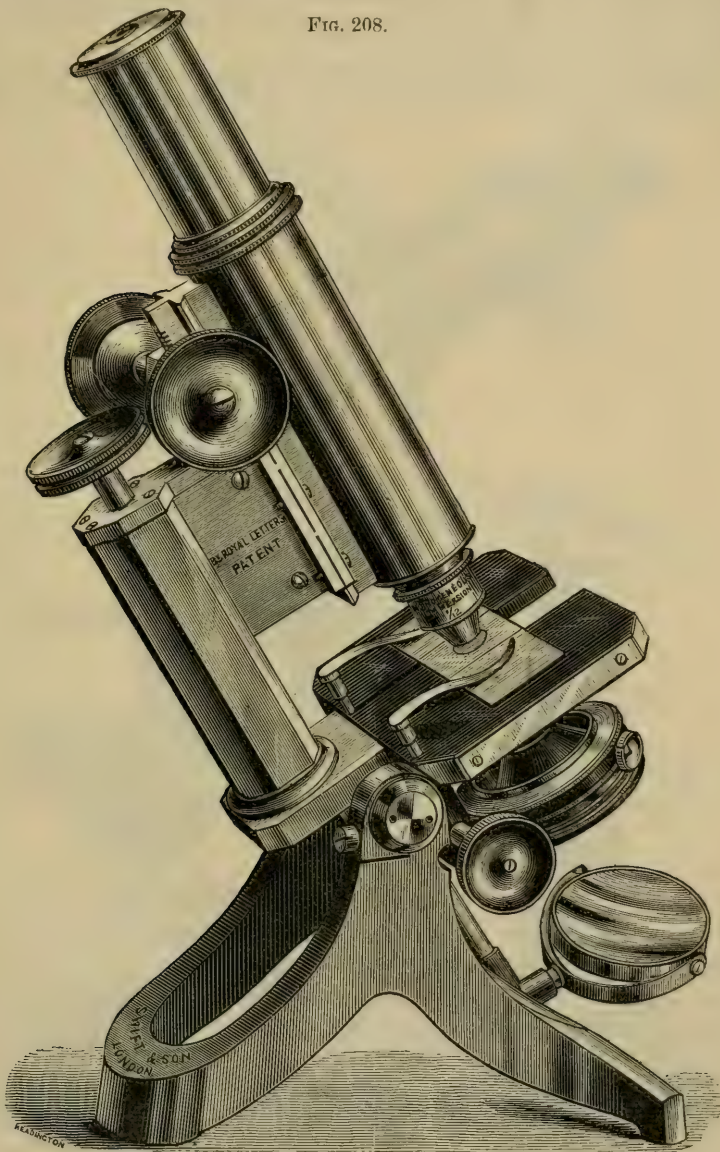
convenient for mounting purposes, as shown by Mr. Deby's Twin Microscope.* Three bodies and three objectives (by which three observers can look at three different objects at once) do not, however, afford the convenience of the former arrangement, while they make a useless addition to the latter.

The three objectives have a common focusing arrangement, no provision being made for focusing separately objectives of different powers.

* See this Journal, 1886, p. 854.

Crookshank's Bacteriological Microscope.—Messrs. Swift and Son have recently brought out this instrument (fig. 208), under the instructions of Dr. E. M. Crookshank, specially for bacteriological work.

FIG. 208.



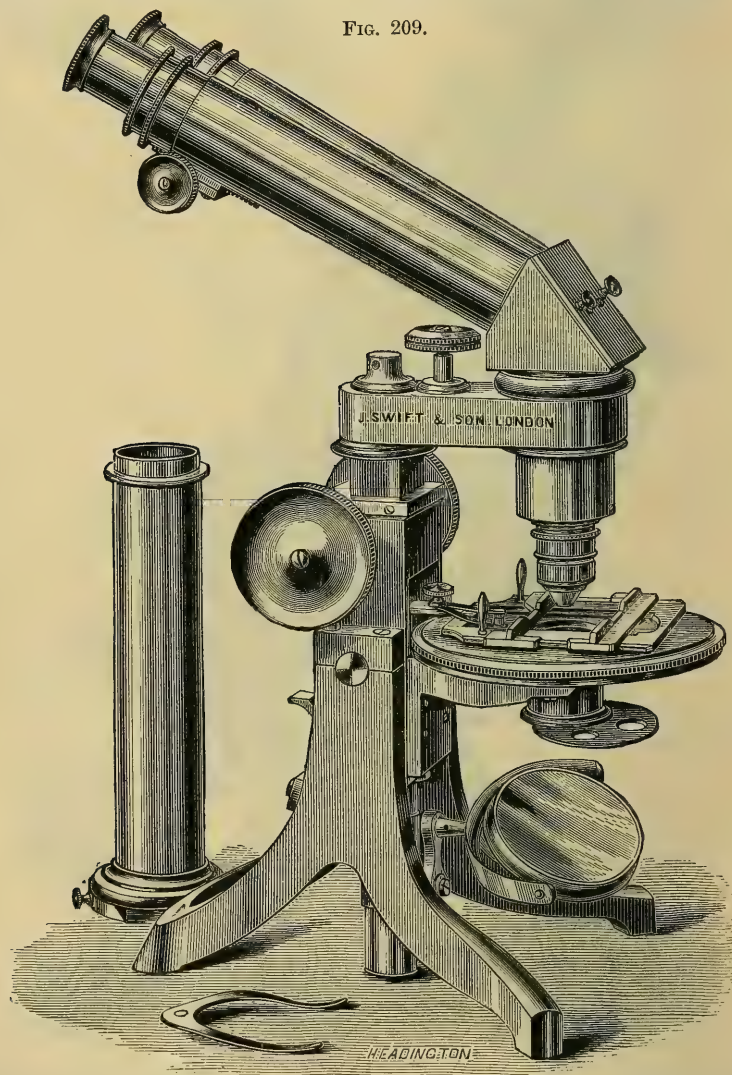
It is provided with an extra large stage with glass surface, which is slotted in the centre to facilitate focusing with high powers, and the removal of the slides. A modified form of the Abbe condenser, with high angle, is applied to the centering substage and fine crossed lines are ruled on the

upper surface of the condenser to mark the centre. The focus of the condenser is adjusted by rack-and-pinion movement.

The principal novelty, however, is in the application of a *lever* to the parallel-spring fine-adjustment of Bausch and Lomb, by which Messrs. Swift have greatly lessened the speed of the movement, at the same time reversing the action of the focusing screw.*

Stephenson's Erecting Binocular Microscope.—Mr. J. W. Stephenson's Erecting Binocular Microscope has approved itself to microscopists, and

FIG. 209.



especially to botanists, as by far the most practical and convenient form hitherto devised where high powers are to be used. Indeed, with the

* See *infra*, p. 808.

higher power objectives it has no rival, as a $\frac{1}{16}$ in. or even $\frac{1}{25}$ in. objective can be used binocularly with full and equal illumination in both tubes. Messrs. Swift & Son now issue it in three forms, two of which are shown in figs. 209 and 210, the third form being intermediate in size between these two.

FIG. 210.

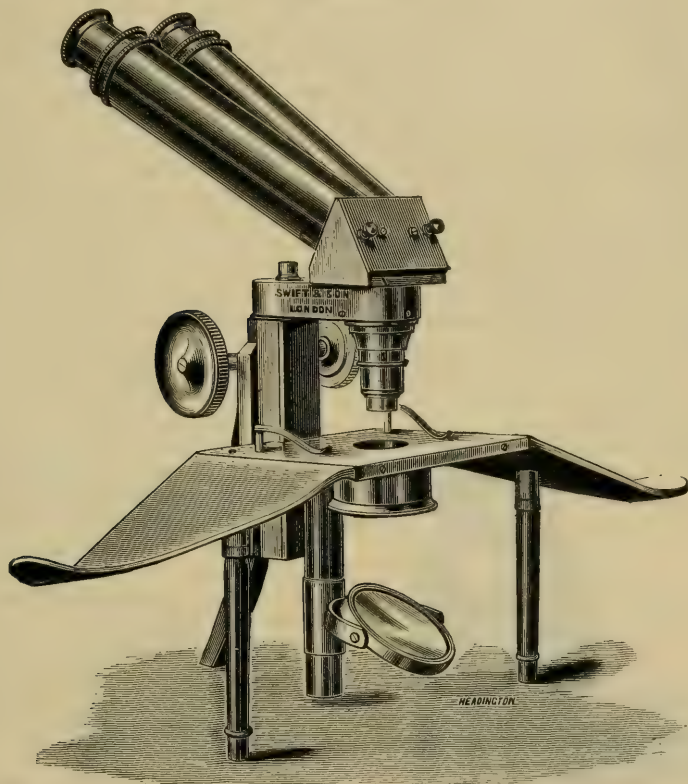


Fig. 210 shows the binocular adapted to a dissecting stand, the erection of the image being especially convenient for making dissections.

The instrument can be readily converted into a monocular when required; the monocular tube is shown in fig. 209.

Gomont's "new" Botanizing Microscope.*—We often have to comment on our German friends for reproducing as novelties microscopical accessories—notably mechanical stages—which have been in existence in this country for many years. We here have a similar case from a French source, the Microscope described as a novelty by M. M. Gomont being a very old friend. We translate the description verbatim:—

"Botanical excursions for collecting algæ and the lower fungi lose, as is well known, a part of their charm and utility in consequence of the difficulty which the botanist experiences in recognizing on the spot the species which he finds. For these small plants a simple lens, whatever may be its amplifying power, is always much too feeble, and it is absolutely

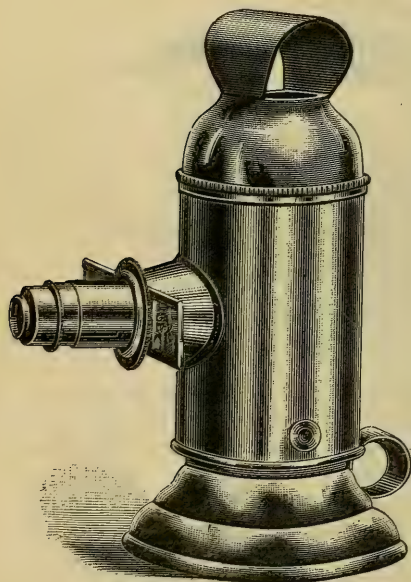
* Bull. Soc. Bot. France, xxxiv. (1887) pp. 216-7.

necessary to have recourse to a compound Microscope. I have endeavoured to modify the form and mode of illumination of this instrument whilst preserving a sufficient power to make it applicable to all cases. The arrangement which I have devised having appeared to some of my colleagues to be very practical I will give here a short description of it.

The instrument consists of an ordinary Microscope tube, sliding smoothly in another tube, which is closed at its lower or objective end by a kind of screw cover which has a small aperture in the centre, which acts as a diaphragm. At the plane of this diaphragm the tube has a slit for the introduction of a slide. A ring sliding on the tube presses on the slide and fulfils the same functions as the clips of a Microscope. The object is illuminated by directing the instrument like an opera-glass to a white cloud or any other brightly illuminated object. The light from these large natural reflectors is sufficient for a power of 250 diameters, a power which it is useless to exceed for the purpose in view, and which it will be very rarely necessary to reach. The preparation of the object to be examined is effected in the field in a very simple manner, the cover-glass adhering sufficiently to the slide to allow of all possible positions being given to the instrument. The diaphragm can be readily removed when it is necessary to alter the tube.

As will be seen, I have been obliged to give to this Microscope as simple an arrangement as possible in consequence of the accidents to which an instrument of this kind is exposed during botanizing. I hope that, notwithstanding its little complication, it will be useful to botanists who are addicted to the investigation of the lower plants, or even in a more general way, to naturalists who have taken as the object of their studies the microscopical organisms."

FIG. 211.



Rochester Magic Lantern and Projection Microscope. — Without committing ourselves to the statement of the designers (the Bausch and Lomb Optical Co.) that this, fig. 211, is "the neatest, cheapest, and best lantern ever introduced," and "without exception far superior to any other both for its size and price," it may be admitted that it is a very handy little lantern (8 in. high). It is made entirely of brass, lacquered, and is so arranged that ordinary 3×1 in. slides can be used, and the image projected on a screen.

An additional recommendation (to utilitarian Microscopists at any rate) is that the lamp "being a regular hand-lamp, makes the lantern more valuable, as the same can be used at any time about the house."

Schott's Microscopes.—On pp. 148–150 we directed attention to certain figures of Microscopes from Schott's '*Magia Universalis*,' published in 1657, which had long puzzled microscopists by their apparently exceptional and extraordinary size. We submitted an explanation, namely, that

the draughtsman, knowing possibly nothing of the purposes of the instruments, instead of drawing *an eye* directed upon them, drew full-length figures, whence by comparison the Microscopes appear of enormous size. This explanation was suggested to us by certain figures of Microscopes in Traber's 'Nervus opticus,' published in 1690, which we reproduced in support of our view of the matter. We have since met with the first edition of Traber's work, published in 1675, in which the same figures were given. On comparing Traber's descriptions with those given by Schott we are strongly confirmed in our opinion that the former was referring to the same Microscopes as those described by the latter.

In support of our explanation we remark that our fig. 13 from Schott's 'Magia Universalis' does not correspond with his own *description* of it (loc. cit., p. 535), for he states that the Microscope is "super tripedale fulcrum," though the drawing shows a cylindrical tube-support without any visible means of illuminating the objects, and such as, in our opinion, was never actually constructed. Whereas Traber's figure (our fig. 16) answers fairly to Schott's description, the open tripod support being a practical form that clearly forms a link in the evolution of the mechanical designs of Microscopes.

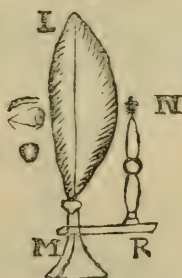
We omitted to note that Schott assigns the construction of the instrument to Eustachio Divini thus:—"Huius modi microscopia excellentissima facit Romæ Eustachius Divini . . ." (loc. cit.).

In further confirmation we remark that in another drawing given by Schott (our fig. 212) a candle and a lens are shown, and by comparison with the full-length figure of a man kneeling and viewing the candle through the lens the latter might be supposed 3-4 feet in diameter, quite beyond the possibility of manufacture at that date. Schott states that from Kircher's 'Ars magna lucis et umbræ' (1646) he found the lens was

FIG. 212.



FIG. 213.

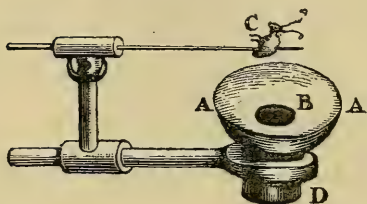


designed by Descartes to have hyperbolic surfaces. On reference to Kircher's text we find Descartes and the hyperbolic surfaces mentioned, thus identifying the instrument, but the figure illustrating the text again shows *an eye* only directed to the lens (vide fig. 213 reproduced from Kircher), whence by comparison the lens appears to be only 4-5 in. in diameter, a size that may have been reached at that date. In reproducing Kircher's woodcut Schott's draughtsman is thus clearly proved to have substituted a full-length figure of a man for the representation of the eye only of the original; the probability of his having done so likewise with other drawings is hence easy to understand and our conjecture is thus shown to have been the true explanation.

Another ludicrous feature may also be noted, viz.:—that in Kircher's figure the eye is viewing an *insect* through the lens, which Schott's draughtsman apparently mistook for a *candle-flame*, and hence substituted the latter!

Lieberkühn's Microscope.—The earliest representation we have met with of this instrument is in P. van Musschenbroek's '*Essai de Physique*,'* tome ii. pl. xviii. fig. 6, and as we believe it to be hitherto practically unknown to English microscopists we reproduce it in fig. 214.

FIG. 214.

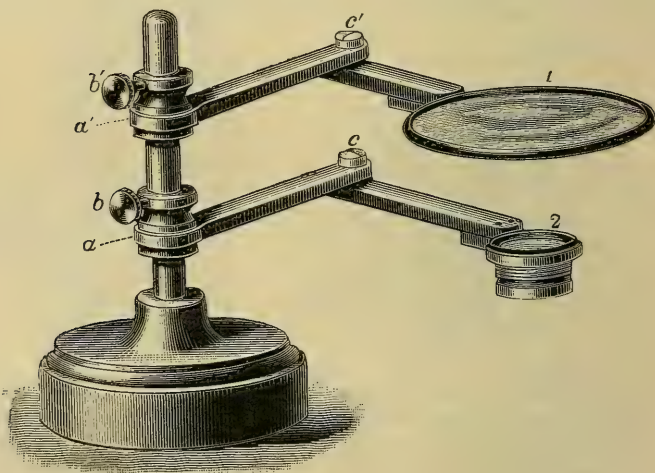


The following is a translation of Musschenbroek's description (loc. cit., p. 595) of the figure:—

"There has also been recently discovered a good way of strongly illuminating large opaque objects, so that they may be examined by every kind of Microscope, even by means of the smallest kinds. A A is a small spherical concave mirror of fine silver, well ground and polished, whence the light is reflected to a focus on the object C, so that it is strongly illuminated at the back. This mirror is pierced in the middle B, and the Microscope [lens or object-glass] is there inserted and adjusted either forward or backward: the eye is placed at D and the object is seen very clearly."

Weinzierl's Simple Microscope for the Examination of Seeds.†—This instrument (fig. 215), the invention of Dr. v. Weinzierl, consists of a solid brass stand leaded at the foot, and carrying two arms jointed at *c'* and *c*, at

FIG. 215.



the extremity of which are lenses 1 and 2. The arms move horizontally round through the bearings at *a* and *a'*, and they are fixed by the screws *b* and *b'* in any desired position.

The weaker lens No. 1 is a simple biconvex lens 9 cm. in diameter, and with a focal distance of 25 cm. It has a magnifying power of $2\frac{1}{2}$ times. No. 2 is more powerful. It consists of two achromatic lenses 29 mm. in

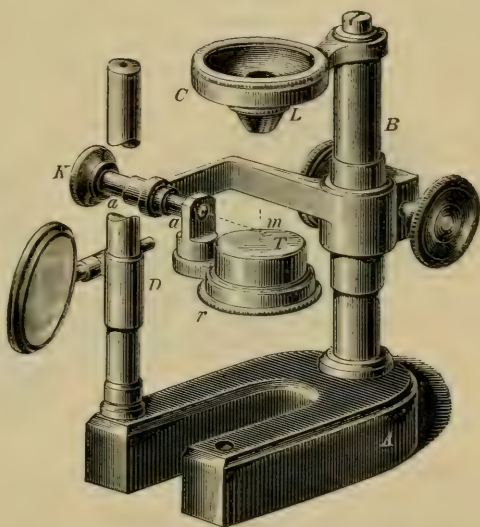
* 2 vols 4to, Leyden, 1739. † Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 42-4 (1 fig.).

diameter, and has a focal distance of 14 cm. It magnifies about 5 times. The advantages claimed for this instrument are that with No. 1 lens both eyes can be used at once, the field of vision is considerable, and both hands are left free for manipulation. If greater magnification be desired, No. 2 lens is easily put in position, or both may be employed at the same time.

Vogel's Lens-stand for Entomological purposes.*—This apparatus (fig. 216), has been for many years used by Prof. H. C. Vogel in the study of small insects.

On a horseshoe foot *A* is a brass pillar *B*, which carries a conical piece *C* to hold the lenses. *T* is the stage which is raised or lowered on the pillar *B* by rack and pinion, and so focused to the lens *L*. The lenses supplied with the apparatus are all set in conical fittings which drop into *C*. The important feature of the apparatus is the facility for moving the stage into any desired position. It consists of a cork *T*, set in a brass ring, terminating below in a milled head *r*, by which the stage is rotated in its own plane, while by the milled head *K* it can be rotated about a horizontal axis *aa*. This axis is also made to slide in its bearings, so that different small objects fixed in a line on *T* can be successively brought into the centre of the field. Thus, the object *m* when placed at a point on the prolongation of *aa*, is capable of a fourfold movement without having materially to alter the focal adjustment. *D* is the illuminating lens which slides along a brass pillar fixed in either of two holes upon the ends of the horseshoe foot, so that the object can be illuminated from either side. This lens may also be conveniently used in mounting large objects, for which purpose it is raised to the top of the pillar and swung round to occupy the position of *C* which is thrown back. For transparent objects the cork is replaced by a glass plate.

FIG. 216.



Westien's improved Universal Clamp for Lens-holders, &c.†—The clamp of Herr H. Westien, the construction of which was described in 1885,‡ has since received improvements which have not only made its production easier but have considerably widened its field of utility. This clamp renders it possible by a single screw motion to clamp securely to an upright an object provided with a bar of any form, whether round, oval, triangular, square, or flat. The upright may also vary in size from 2–9 mm., from

* Zeitschr. f. Instrumentenk., vii. (1887) pp. 173–5 (1 fig.).

† Ibid., pp. 54–5 (1 fig.).

‡ See this Journal, 1885, p. 316.

5–13 mm., or from 7–15 mm., according to the clamp used, and may also be round, oval, triangular, square, or flat in section. The construction is as follows (fig. 217).

On the pin A having a hook-shaped head, is the cup B, the clamp C, and the nut D, which is provided with a washer. D works upon a screw-thread on the pin, and when screwed up presses together the clamp C and the cup B, by which the bar H is clamped in the angle of C, while on the other side the hook draws the cup against the upright J, so that J and H are firmly clamped together by the single screw D.

FIG. 217.

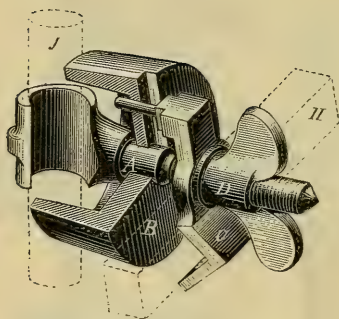
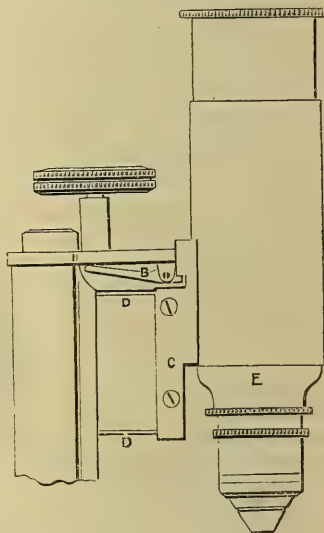


FIG. 218.



Swift's Lever and Parallel-spring Fine-adjustment. — Messrs. Swift and Son, as noted *supra*, p. 218, have applied a lever to the parallel-spring fine-adjustment of Bausch and Lomb by which the speed of the movement is much lessened. The mechanism is shown in fig. 218 (reduced from the drawing to the specification of the patent).

The milled-head screw acts upon the lever B, the short end of which engages in the piece C, which is attached to the body-tube E, and is supported at the back by the parallel springs D D connected with the stem.

The movement of the screw raises or lowers C at a very slow rate against the tension of the springs DD.

NEUMANN, C.—*Die Brillen, das dioptrische Fernrohr und Mikroskop. Handbuch für praktische Optiker.* (Spectacles, the dioptric Telescope and Microscope. Handbook for practical opticians.) 256 pp. and 60 figs., 8vo, Wien, 1887.

STEIN, S. T.—*Die Optische Projektionskunst im Dienste der exakten Wissenschaften.* (The art of optical projection in aid of the exact sciences.)

[Reprint from Part V. of 'Das Licht.' Cf. *ante*, p. 161. Contains a chapter on "the Projection of Microscopic Objects."]

viii. and 155 pp., 183 figs., 8vo, Halle a. S., 1887.

Woodhead's *Microscope* with large stage for the examination of sections through entire organs. *Brit. Med. Journ.*, 1887, No. 1391, p. 469.

(2) Eye-pieces and Objectives.

BURRILL, T. J.—A new Objective.

[Report of examination of a Zeiss 2 mm. apochromatic objective and eye-pieces.

"The objective has shown itself to be of very high grade among those of modern production, but judging by results obtained it cannot reveal anything not heretofore seen under similar circumstances with the best work of at least six opticians."]

The Microscope, VII. (1887) pp. 233-7.

SCHÜLL, P.—Ueber das Centriren optischer Linsen. (On the centering of optical lenses.)

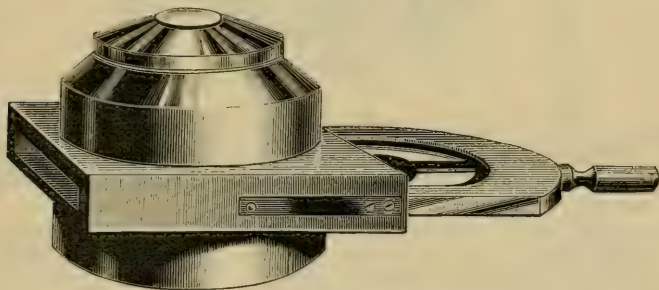
[Practical directions.]

Central-Ztg. f. Opt. u. Mech., VIII. (1887) pp. 181-2, 194-6 (3 figs.).

(3) Illuminating and other Apparatus.

Bausch and Lomb Condenser and Substage.*—This (fig. 219) consists of a condenser and substage, the latter having five stops, diaphragms and blue glass. The lenses of the condenser are of such a size as to utilize almost all the rays of light which may pass through the substage ring. In order that objectives having a large aperture may be used, the condenser

FIG 219.



has been made with a numerical aperture of about 1.42 (another of 1.20 is also manufactured). Its volume of light is sufficient with the highest amplification, and although it gives an intense light at the focal point it may be distributed over a large space by varying its distance from the object. It will work both dry and immersion. The mounting of this condenser is new and simple, and is so arranged that the instrument can be used where the substage is adjustable or fixed. The diaphragms are separate.

Reichert's improved Mechanical Stage.†—Prof. E. F. v. Marxow describes an improvement of Reichert's mechanical stage which allows it to be fitted to any Microscope without requiring any alteration of the stand. In the original form it will be remembered the stage was fitted to the Microscope by passing the bar projecting from the posterior side of the stage through an aperture cut in the pillar of the Microscope, the bar having rackwork on it by which the stage was moved backwards and forwards. In the new form the pillar is not required to be pierced, but the stage is clamped to the pillar.

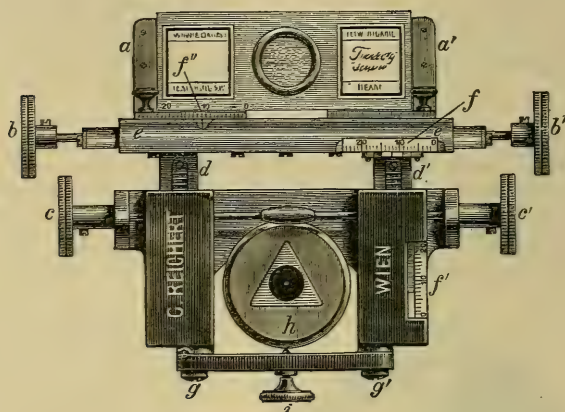
The posterior part of the stage (fig. 220) consists of two parallel bars *dd'* on the upper surface of which is rackwork. These bars are joined together by the pieces *cc'* and *gg'*, the former being hollowed out in order

* *The Microscope*, vii. (1887) p. 16 (1 fig.).

† *Zeitschr. f. Wiss. Mikr.*, iv. (1887) pp. 25-30 (1 fig.).

to fit against the pillar *h* of the Microscope. The piece *g g'* turns on *g'*, in order that the stage may be slipped on the Microscope, and this done, it is held in position by means of the steel-pointed screw *i*. The piece *c c'* is terminated at each end by a milled head, which, in connection with the

FIG. 220.



rackwork on *d d'*, moves the stage backwards and forwards. These two bars *d d'* are also connected with *a a'*, upon which the slide rests. Lateral movement is obtained through *e e*, which is a slotted cylinder terminated at each end by the milled heads *b b'*.

The scales *f* and *f'* enable any particular point of the preparation to be found again, but if the slide has been removed from the stage it is necessary also to note the reading of the scale *f''*.

Borden's Electrical Constant-temperature Apparatus.*—Dr. W. C. Borden describes an apparatus for maintaining a constant temperature, which will not easily get out of order, and can be depended upon to maintain the temperature desired, intended more especially for the use of those who have no gas at command, but have to use either petroleum or alcohol as a source of heat. It can be left for hours with the certainty that when again examined the heat will not have gone above a certain point or have dropped at any time more than one-half or possibly one degree below it.

The general form of the entire apparatus is shown in fig. 222, and the regulating thermometer in fig. 221. The battery used is the ordinary gravity battery used in telegraphy which gives a current of nearly constant quantity, and requires but little attention.

The regulating thermometer (fig. 221) is made by taking a small glass vial, filling the lower part with mercury and the upper with 95 per cent. alcohol, corking it tightly and passing a small glass tube through the cork at the bottom. The cork must fit very closely and should be made impervious to water by soaking in melted paraffin for several hours. The top of the tube is to be loosely corked and two wires passed down into it through the cork without touching each other—one A well down into the mercury, and the other B free above it. This regulating thermometer is now hung in the water-bath supported by the cork C, and when the temperature of the bath, as shown by a standard thermometer, has reached

* Amer. Mon. Micr. Journ., viii. (1887) pp. 131-3 (2 figs.).

the highest point desired the wire above the mercury is pushed down so as just to touch the surface of the latter. It is obvious that if the bath be filled with water below the temperature desired the mercury will not rise and touch the wire B, thus making connection with the other wire, until

FIG. 221.

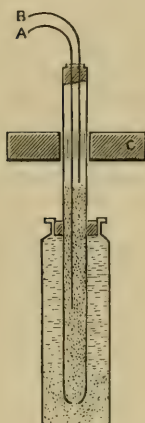
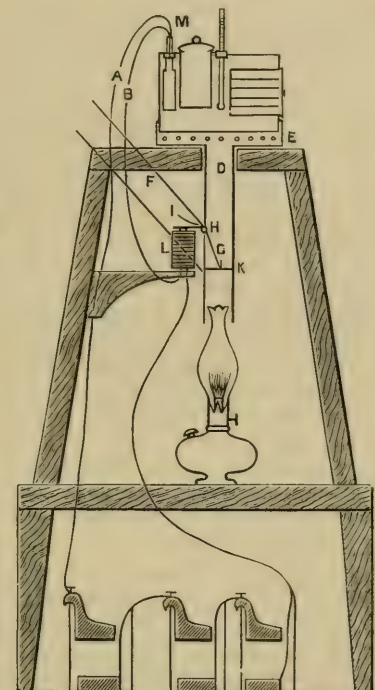


FIG. 222.



the bath reaches that temperature, and that as soon as the temperature falls below this point the mercury will fall with it and away from the wire B; also that by raising or lowering this wire the connection can be made to take place at any desired higher or lower temperature. This regulating thermometer will be found to be sufficiently delicate to keep the temperature to within two degrees. It can be made by simply blowing a bulb on a glass tube and filling the bulb and tube with mercury alone.

Fitting over the top of the lamp-chimney is a chimney D, 11 in. long and $2\frac{3}{4}$ in. square, having at its top a hot-air chamber E, into which the water-bath fits. This chamber has holes round the sides near the bottom for the escape of air. The chimney D has at one side a branch chimney F, 12 in. long, opening into it at an angle of 45° . In the opening between the chimneys is hung a valve G, turning on a hinge H, and moved by a lever I on the outside. This valve should be very light, and must turn easily on the hinge which is made by hanging the valve fastened on a wire through holes on the sides of the chimney; to this wire is attached on the outside the lever which is to be weighted on the end with a small bullet, so as nearly to balance the valve which must just fall of its own weight. At K is a shelf $2\frac{1}{4}$ in. wide extending into the chimney D. This shelf leaves an opening in the chimney $1\frac{1}{2}$ in. wide which is sufficient for

the passage upwards of the hot-air, and which can be readily closed or opened by the valve without too far swinging. At L is an electro-magnet, which is connected with one pole of the battery and with the regulating thermometer by means of the wire B. The regulating thermometer is connected with the other pole of the battery by means of the wire A.

The action of the apparatus is sufficiently plain. The lamp being lighted, the temperature of the water-bath will rise, and the mercury in the regulating thermometer M with it, until it touches the wire B, thus closing the circuit and magnetizing the electro-magnet, which will attract the lever I, pulling it down, and raising the valve G, so closing the opening in the chimney K, when the heat will escape by the branch chimney F. The temperature of the bath will now fall slightly, and the mercury with it away from B, thus breaking the circuit and demagnetizing the electro-magnet, which will cease to attract the lever, and so allow the valve to fall of its own weight, closing the opening into the branch chimney and allowing the hot air to again ascend through K and reheat the water-bath. This regulating action will continue as long as any oil remains in the lamp, which should therefore have a large reservoir and the flame be turned only high enough to keep the bath slightly above the temperature desired. "With this apparatus many processes such as Weigert's hæmatoxylin staining of the nervous system, which, without a constant temperature of long continued duration are impossible of performing, are made easy; and any one who has had the bother of watching a bath while imbedding in paraffin will appreciate the gain arising from an apparatus which will run all night and have the tissues in good condition for imbedding in the morning, to say nothing of the many other uses, besides staining and imbedding, to which it can be put."

Lighton's Analysing Diaphragm for the Polariscope.* — Mr. W. Lighton describes this apparatus as follows, stating that he has found it to be of great help in the study of crystallography.

"We will suppose that the polariscope as ordinarily used has been placed in position, the polarizing prism below the stage and the analysing prism above the objective. The apparatus consists simply of a cap with movable diaphragm placed over the eye-piece, as illustrated in figs. 223 and 224. Fig. 223 is a sectional view, and fig. 224 a top view of the cap of the eye-piece. The letters in both figs. refer to the same parts. Let AA indicate the axis of the tube; B, the eye-piece; C, the cap of the eye-piece. The apparatus consists merely in a diaphragm plate D, swinging from right to left on the pivot I. This motion is given by placing the finger at the knob L. The amount of motion is controlled by the two small studs G. The diaphragm is pierced by a small hole H, $\frac{1}{8}$ in. in diameter. E is a screw in the top of I, holding the diaphragm in place. F is the apex of the cone of light formed by the image of the source of light passing through the eye-piece. Now, if the diaphragm be so adjusted by sliding the cap upon the eye-piece that it will be on a level with this point of light a very interesting series of optical effects will be observed. The small studs G should be so placed that when the diaphragm is swung to the right or left the sides of the hole H will just cut the axis of the eye-lens (apex of cone of light).

I will mention a few of the sights seen by its use as described above. In no case were the prisms of the polariscope revolved. A crystal of chlorate of potash was selected, which, upon simply revolving the stage, passed merely from an orange-purple to a dull grey. On introducing the cap and

* Amer. Mon. Mier. Journ., viii. (1887) pp. 169-10 (2 figs.).

passing the diaphragm from right to left a beautiful series of the most brilliant tints was seen—a fine navy blue changing to purple, orange, and then to lemon-yellow, and lastly pale straw colour. A section of fortification agate was taken which showed a small crystal of pure quartz in one portion. With the diaphragm used as before from right to left, the colour

FIG. 223.

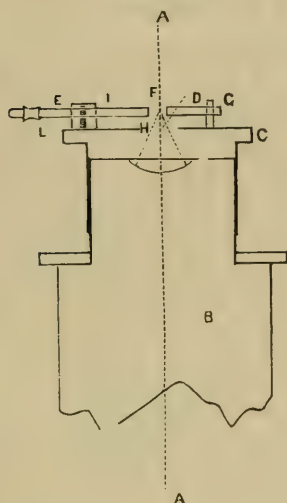
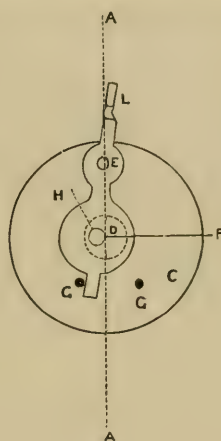


FIG. 224.



of the crystal was merged from bright-green to magenta, and then to a velvety brown-red. With the usual revolution of the stage the colours exhibited were green fading to a dull black.

With this apparatus there is not only a more varied and brilliant series of colours, but also a marked intensification of points of structure. In the two above-mentioned slides delicate lines of crystallization were shown which were invisible under ordinary circumstances.

One of the small, curiously-branched bones of the red-horse, a fish common in this region, was examined, and showed the bone-cells in a remarkably distinct way, they being quite indistinct without the diaphragm."

Auer's Incandescent Gas-burner as a Microscope Lamp.*—Dr. K. Bürkner recommends Auer's gas-lamp for use with the Microscope. He has employed it for some time and finds it very satisfactory both in power and quality. The light emitted is intense, but not blinding, and is relatively white as compared with the ordinary gas-flame or that from paraffin. Another advantage is the small amount of heat given off. The lamp is merely an ordinary Bunsen's burner, the flame of which is surrounded by a chimney or sheath impregnated with the nitrates of cerium, didymium, lanthanum, itrium. The incandescent chimney is upheld by a platinum wire tied to a bearer which can be raised or lowered by means of a screw, and is further inclosed in a glass chimney. As the incandescent chimney consists of ash, it is necessarily somewhat susceptible of damage.

* Zeitschr. f. Wiss. Mikr., iv, (1887) pp. 35-8 (1 fig.).

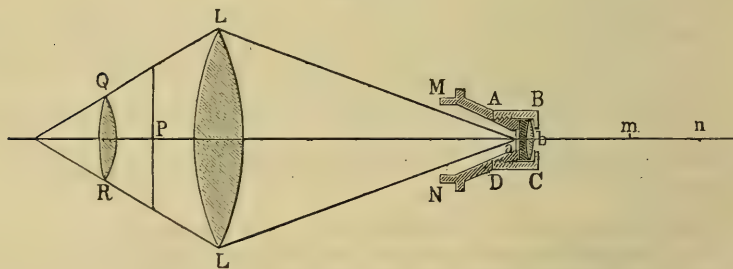
This is apparently the only inconvenience associated with the burner, and is more than compensated by the advantages of the light.

"Old and New Microscopical Instruments."—Apparatus for testing Refractive Index.*—The text of Dr. G. Martinotti's article under the above quoted title is that there is nothing new under the sun, and as here applied, he remarks how frequently the newer apparatus is but an improvement on, or a perfecting of, some older instrument. As an example, he refers to Prof. H. L. Smith's apparatus for determining the refractive index of liquids.†

Between two plates of crown glass is formed a space, one side of which is flat, the other concave. When the cavity is filled with a liquid with higher refractive index than that of glass, a plano-convex lens is the result. By means of a simple device this artificial lens is fitted behind the weak objective of a compound Microscope, so that the two form an optical system. Then, according to the difference in the refractive index of the interposed lens, the image of the object examined falls at a different distance, and the amount of displacement imparted to the optical arrangement in order to see the object clearly gives the refractive index of the liquid under examination.

The author then remarks that the principle had been previously applied for the same purpose, but in a somewhat different manner. The reference is to Sir D. Brewster's 'Treatise on new Philosophical Instruments for various purposes in the arts and sciences,' Edinburgh, 1813. In this, at p. 240, will be found the 'Description of an instrument for measuring the refractive power of fluids. . . .' There Brewster refers to the fact that Euler had already conceived the notion of determining the refractive indices of liquids by inclosing them between two lenses (menisci). This idea was carried out, though imperfectly, by his son. Brewster's device was as follows (p. 247):—In the extremity M N of a Microscope fitted with its objective is placed a thin plate of glass *a*. The biconvex lens *b* is fixed to the end of a short tube A B C D, screwed on to M N so that the internal

FIG. 225.



surface of the lens could be made to touch the plate *a*, or removed away from it. In A B C D, just behind the lens *b*, are two holes for the introduction of fluids into the cavity between *a* and *b*. Thus is formed a plano-convex lens which can be diminished or increased in size by altering the position of the screw.

The plano-convex lens increases the focal length of *b*, and therefore forms the image of any object *m*, at a greater distance from the point P, situate at the anterior focus of the ocular Q R. But as the lenses Q R and

* *Zeitschr. f. Wiss. Mikr.*, iii. (1886) pp. 320-30 (1 fig.).

† See this Journal, 1885, p. 1066.

L L are fixed, the object must be removed to a in order to get a distinct image at the point P, and the greater the density of the fluid the longer the distance from b . Hence bm , bn give the relative value of the refractive index of the liquid under examination, and with a little calculation the absolute value also. In his research Brewster kept the distance between the lenses invariable, and the thickness of the plano-convex lens identical, for all cases under examination. The objects used were scratches on the surface of a piece of glass. He adds an important detail which has been passed over by Smith. Across the diaphragm at the anterior focus of the ocular he stretched a very fine thread, which, as well as the mark in front of the objective, he tried to keep distinctly in view, in order to prevent any error depending on the eye of the observer.

The fundamental principle of the two instruments is alike, although, instead of a plano-convex lens of definite thickness, in the older apparatus the thickness was variable. It is more convenient, however, for the artificial lens to have constant dimensions as in Smith's apparatus, and not variable ones as in Brewster's instrument, for when the distance which it is necessary to remove the objective from the object in order to see it distinctly is known, the calculation is readily made.

A plate of glass is placed behind the objective, and the latter removed to such a distance from the object (say a micrometer) that it is seen distinctly. Let this distance be p . The cavity containing the liquid to be examined is then placed behind the objective. In order that the eye behind the ocular Q R may clearly distinguish the micrometer image at P, it becomes necessary to remove the objective to a further point p' . Let P indicate the distance at which, in both cases, the image of the micrometer is formed behind the objective; f the focal length of the biconvex lens b ; f' that of the added lens; and F the focal length which results from the combination of the two lenses.

From the law of conjugate foci

$$\frac{1}{p} + \frac{1}{P} = \frac{1}{f} \quad \text{and} \quad \frac{1}{p'} + \frac{1}{P} = \frac{1}{F}.$$

By subtraction—

$$\frac{1}{p} - \frac{1}{p'} + \frac{1}{P} - \frac{1}{P} = \frac{1}{f} - \frac{1}{F};$$

or

$$\frac{1}{p} - \frac{1}{p'} = \frac{1}{f} - \frac{1}{F}.$$

But

$$\frac{1}{F} = \frac{1}{f} - \frac{1}{f'};$$

and on substituting this value in the previous equation we have

$$\frac{1}{p} = \frac{1}{p'} = \frac{1}{f} - \frac{1}{f} + \frac{1}{f'} = \frac{1}{f'}.$$

Next let n be the index of refraction of the artificial lens, and r its radius of curvature: then as

$$\frac{1}{f} = \frac{n-1}{r},$$

we have

$$\frac{1}{p} - \frac{1}{p'} = \frac{n-1}{r}.$$

If the value of r be accurately known, it becomes easy to find the value of n :

$$n - 1 = r \left(\frac{1}{p} - \frac{1}{p'} \right)$$

$$n = 1 + r \left(\frac{1}{p} - \frac{1}{p'} \right) \dots a.$$

But as in practice it is difficult to determine the exact value of r , it is better to find, not the absolute refractive index of the liquid, but that relative to a substance the refractive power of which is already known, for example, glass or water.

Let n' be the index of refraction of the comparing substance, and p'' the distance to which in this case the objective is moved from the micrometer; the formula then becomes

$$\frac{1}{p} - \frac{1}{p''} = \frac{n' - 1}{r},$$

from which

$$r = \frac{n' - 1}{\frac{1}{p} - \frac{1}{p''}} = (n' - 1) \left(\frac{1}{\frac{1}{p} - \frac{1}{p''}} \right).$$

By substituting the value of r in the equation a we get

$$n = 1 + (n' - 1) \left(\frac{1}{\frac{1}{p} - \frac{1}{p''}} \right) \left(\frac{1}{p} - \frac{1}{p'} \right),$$

or

$$n = 1 + (n' - 1) \frac{\left(\frac{1}{p} - \frac{1}{p'} \right)}{\left(\frac{1}{p} - \frac{1}{p''} \right)}.$$

But

$$\frac{\frac{1}{p} - \frac{1}{p'}}{\frac{1}{p} - \frac{1}{p''}} = \frac{\frac{p' - p}{pp'}}{\frac{p'' - p}{pp''}} = \frac{p'' (p' - p)}{p' (p'' - p)} = \frac{p''}{p'} \frac{p' - p}{p'' - p} = \frac{p''}{p'} \frac{p (p' - p)}{p (p'' - p)},$$

and the equation becomes

$$n = 1 + \frac{p''}{p'} \frac{p' - p}{p'' - p} (n' - 1) \dots \beta.$$

Where the value of n' , that is the refractive index of the liquid used for comparison, is known, and the other values, that is, the distances between the objective and the object, it becomes sufficiently easy to make the required calculation.

Instead of measuring these distances, it is possible and more convenient to calculate them. In the three cases before us let us suppose these to be g g' g'' : then when the optical arrangement remains the same, there is a constant relation between these and the focal length of

$$gp = gp' = g''p'' \dots \gamma.$$

In the equation β the values of p p' p'' may be expressed in functions of g g' g'' taken from equation γ .

Then

$$p'' = \frac{gp}{g''} p' = \frac{pg}{g'},$$

and

$$\frac{p''}{p'} = \frac{\frac{gp}{g''}}{\frac{pg}{g'}} = \frac{g'}{g''}.$$

Again,

$$p' - p = \frac{gp}{g} - p = p \left(\frac{g}{g'} - 1 \right),$$

and

$$p'' - p = \frac{gp}{g''} - p = p \left(\frac{g}{g''} - 1 \right).$$

By substituting in equation β these values,

$$n = 1 + \frac{g'}{g''} \frac{p \left(\frac{g}{g'} - 1 \right)}{p \left(\frac{g}{g''} - 1 \right)} (n' - 1),$$

or

$$n = 1 + \frac{g'}{g''} \frac{\frac{g}{g'} - 1}{\frac{g}{g''} - 1} (n' - 1),$$

from which

$$n = 1 + \frac{g' \left(\frac{g}{g'} - 1 \right)}{g'' \left(\frac{g}{g''} - 1 \right)} (n' - 1),$$

and lastly,

$$n = 1 + \frac{g - g'}{g - g''} (n' - 1).$$

This calculation is for Brewster's instrument, in which the artificial lens is plano-concave. In Smith's apparatus, in which the lens is plano-convex, the fraction $\frac{1}{f'}$ changes sign, so that $\frac{1}{F} = \frac{1}{f} + \frac{1}{f'}$.

In the two equations which express the law of conjugate foci,

$$\frac{1}{p'} + \frac{1}{P} = \frac{1}{F}, \quad \frac{1}{p} + \frac{1}{P} = \frac{1}{f}$$

by subtraction

$$\begin{aligned} \frac{1}{p'} + \frac{1}{P} - \frac{1}{p} - \frac{1}{P} &= \frac{1}{F} - \frac{1}{f} \\ \frac{1}{p'} - \frac{1}{p} &= \frac{1}{F} - \frac{1}{f}. \end{aligned}$$

Substituting for $\frac{1}{f}$ its value we get

$$\frac{1}{p'} - \frac{1}{p} = \frac{1}{f} + \frac{1}{f'} - \frac{1}{f} = \frac{1}{f'}.$$

Now

$$\frac{1}{f'} = \frac{n-1}{r};$$

then

$$\frac{1}{p'} - \frac{1}{p} = \frac{n-1}{r};$$

from which

$$n-1 = r \left(\frac{1}{p'} - \frac{1}{p} \right)$$

$$n = 1 + r \left(\frac{1}{p'} - \frac{1}{p} \right) \dots \alpha.$$

With the liquid used for comparison the equation becomes

$$\frac{1}{p''} - \frac{1}{p} = \frac{n'-1}{r},$$

whence

$$r = n' - 1 \frac{1}{\frac{1}{p''} - \frac{1}{p}}.$$

By substituting the value of r in the equation α we get

$$n = 1 + (n' - 1) \left(\frac{1}{\frac{1}{p''} - \frac{1}{p}} \right) \left(\frac{1}{p'} - \frac{1}{p} \right)$$

$$n = 1 + (n' - 1) \frac{\frac{1}{p'} - \frac{1}{p}}{\frac{1}{p''} - \frac{1}{p}}.$$

But

$$\frac{\frac{1}{p'} - \frac{1}{p}}{\frac{1}{p''} - \frac{1}{p}} = \frac{\frac{p-p'}{p'p}}{\frac{p-p''}{p''p}} = \frac{p''p(p-p')}{p p' (p-p'')} = \frac{p''(p-p')}{p'(p-p'')} = \frac{p''p-p'}{p p - p''}$$

then

$$n = 1 + (n' - 1) \frac{p''p-p'}{p' p - p''} \dots \beta'.$$

By substituting for $p p' p''$ their values in functions of $g g' g''$, and remembering that

$$g p = g' p' = g'' p'',$$

and that consequently

$$p'' = \frac{p g}{g''} p' = \frac{g p}{g'},$$

we get

$$\frac{p''}{p} = \frac{\frac{g p}{g''}}{\frac{g p}{g'}} = \frac{g'}{g''}.$$

Furthermore,

$$p - p' = p - \frac{g p}{g'} = p \left(1 - \frac{g}{g'} \right)$$

$$p - p'' = p - \frac{g p}{g''} = p \left(1 - \frac{g}{g''} \right).$$

By substituting these values in the equation β' we get

$$n = 1 + (n' - 1) \frac{g' p \left(1 - \frac{g}{g'} \right)}{g'' p \left(1 - \frac{g}{g''} \right)}$$

$$n = 1 + (n' - 1) \frac{g \left(1 - \frac{g}{g'} \right)}{g'' \left(1 - \frac{g}{g''} \right)}$$

$$n = 1 + (n - 1) \frac{g' - g}{g'' - g}.$$

In conclusion, it only remains to be said that these formulæ do not take into account certain values which, if absolute precision were required, ought to come into the calculation (distance of the objective from the artificial lens, radius of curvature of the latter, &c.). Hence these formulæ give only an approximate result, but one which is sufficient for ordinary and practical purposes.

Dr. Martinotti might we think have found many better instances to illustrate his text as to the want of novelty in sub-solar matters, as Prof. Smith's apparatus is certainly a very useful device, and one for which he is entitled to all the credit of independent invention.

DAVIS, T. S.—**New Stage Accessory.**

[Consisting of a slip of glass, from the surface of which a brass pin projects at each end. Over these pins another piece of glass, with corresponding holes drilled in it, slides, and thus objects requiring to be flattened may be conveniently secured for observation.]

16th Ann. Rep. S. Lond. Micr. and Nat. Hist. Club, 1887, p. 12.

Fasoldt's (C.) **Eye-piece Micrometer.**

[“The lines are said to be ground in the glass, not ruled.”]

Journ. New York Micr. Soc., III. (1887) p. 40.

Rogers' (W. A.) **Stage Micrometer.**

[In squares upon speculum metal—parts of an inch and millimetre.]

Journ. New York Micr. Soc., III. (1887) p. 40.

WINKEL, R.—**Apparat zum Markiren mikroskopischer Objekttheile.** (Apparatus for marking parts of microscopic objects.)

[Same as that described, *ante*, p. 468.]

German Patent, Kl. 42, No. 38858, 15th Sept., 1886 (1 fig.).

(4) Photomicrography.

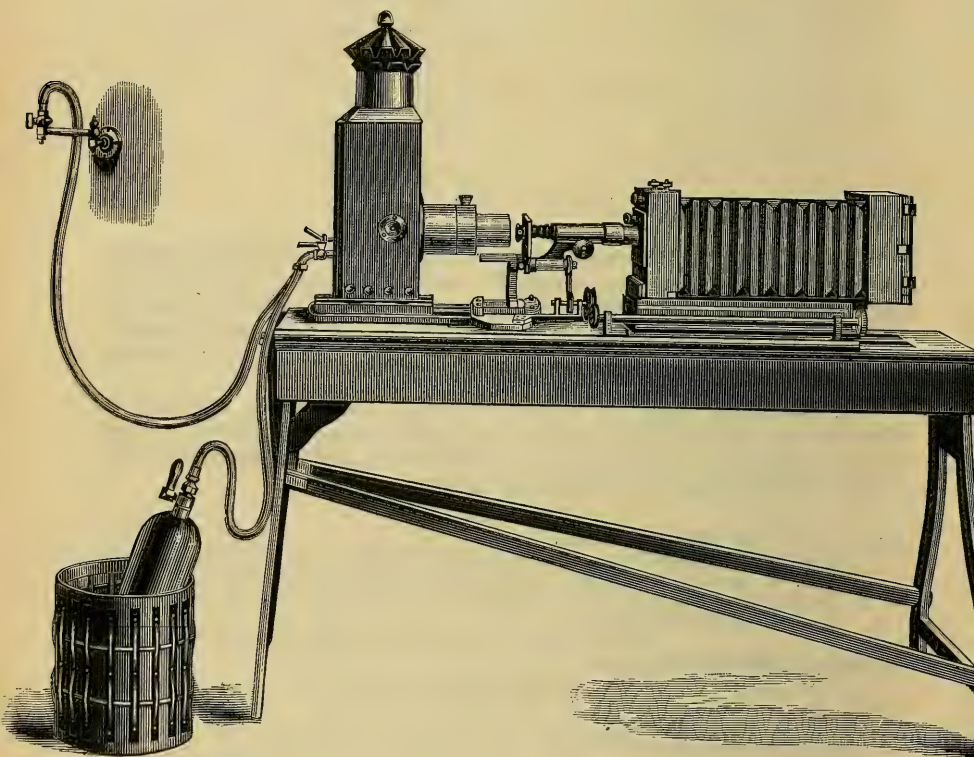
Crookshank's Reversible Photo-micrographic Apparatus.*—Dr. E. M. Crookshank's apparatus (fig. 226) consists of a camera fixed upon a base-board 4 or 5 feet in length, upon which the Microscope is clamped, and

* *Journ. and Trans. Photographic Soc. of Great Britain*, xi. (1837) pp. 144-52 (1 fig.). See also Crookshank's 'Photography of Bacteria,' 1887, p. 22.

which carries also an oxyhydrogen lantern. In order to photograph micro-organisms in liquids or the colony growths in gelatin which has been partially liquefied, the apparatus can be placed in the vertical position so that the stage is horizontal.

To place the apparatus in the vertical position, two small hinged brackets at the end, distant from the camera, are forced up with a smart blow of the hand. The corresponding ends of the stretcher bars are dislodged from their fittings, and allowed to descend; when horizontal, the opposite extremities of the bars are easily released from their sockets. The leg or support at this end can then be turned up and fixed underneath

FIG. 226.



the apparatus by a button, and the end of the apparatus itself gently lowered to the ground. A hinged end-piece is also to be turned out to increase the base upon which the whole apparatus will stand when raised to the vertical. The two-legged support at the opposite end of the apparatus is next worked down by a quick thread screw, and, on raising the apparatus to the vertical, the two-legged support drops to the ground, and assists in maintaining the stability of the whole. If it be thought necessary, a simple means can be readily devised for clamping the apparatus in either position to the wall of the room, so as to eliminate as much as possible all chances of vibration. A second quick thread screw moves the base-board upon which the camera

and central sliding-board are mounted, so that the camera, Microscope, and lantern can be raised to a convenient height above the ground.

The various parts of the apparatus are described more in detail as follows:—The Microscope utilized was one constructed by Zeiss, but any good stand may be adapted in the same way. The advantage of Zeiss's stand, for bacteriological photography, is that the wide stage forms a steady support for cultivations on small panes of glass coated with nutrient jelly. A mechanical stage greatly facilitates manipulation with the highest powers; but it is not indispensable, for Dr. Crookshank has taken, without the use of one, a large number of photographs, though employing, as a rule, a $1/25$ hom. imm. It is most essential that the Microscope should be perfectly steady. To ensure this the horseshoe foot-piece of the Zeiss stand fits under a projecting ledge, and is then clamped by a cross-piece, so that it is firmly fixed.

The Microscope, with the means for clamping it, and the oxyhydrogen lantern are carried upon an independent sliding-board, which admits of movement to or from the camera. The sliding-board also moves upon a centre, which enables the Microscope to be turned out from the median line; in fact, to be turned at a right angle to the position it occupies when ready for the exposure. The object of this contrivance is to enable the operator to sit down by the side of the apparatus, and with comfort to arrange the object in the field of the Microscope. On turning the Microscope back into the median line, it is fixed in the optical axis of the apparatus by means of a stop. The sliding-board was originally provided with a small grooved wheel receiving an endless cord, made of silk or fishing-line, which passed round the grooved, milled head of the fine adjustment. When the sliding-board was returned to the median line of the apparatus, the milled wheel connected with the fine-adjustment impinged upon the wheel of the long focusing rod. The latter was provided with an indiarubber tyre, which gripped the teeth of the milled wheel, and thus the long focusing rod was placed in connection with the fine-adjustment. Dr. Crookshank now dispenses with this arrangement, as he believes it to be a mistake to strain the objective by having the screen at a greater distance from the object than, say, 30 inches, and with that distance of screen one can easily move the fine-adjustment with one hand, while holding the focusing glass in the other.

Of equal importance to the objective is the sub-stage condenser, and this, for the best results, must be provided with arrangements for focusing and accurate centering.

For illumination the author has chiefly employed the oxyhydrogen light, which can be used without the interposition of a mirror in either position of the apparatus. In the horizontal position a paraffin lamp may be employed by simply removing the lantern and substituting the one for the other; but to employ this illumination when the apparatus is vertical would obviously entail another arrangement. It would in this case be necessary to adjust the mirror of the Microscope and to place the lamp in such a position that the light would be reflected in the ordinary way.

If the paraffin lamp be preferred, it should be provided with a large broad wick and a metal chimney. The burner may be made to revolve, so that either the edge or the flat of the flame may be utilized. The metal chimney has an aperture in front, giving exit to the rays of light, which is closed in by a slip of glass. The glass is very liable to crack when exposed to the full force of the flame, and it is as well, therefore, to be provided with a stock of glass slips, which have been annealed by being enveloped in a cloth and boiled for two or three hours.

Dr. Crookshank has, so far, been so satisfied with the oxyhydrogen light, both for taking direct pictures and enlarging, that he has not deemed it worth while to substitute any other. He more frequently employs it than the paraffin lamp, partly on account of the diminished time in exposure, especially when employing very high powers; this is of great importance where there is likely to be vibration from passing traffic. With rapid plates and the highest powers, the exposure has only been two or three seconds, whereas, with the paraffin lamp, it may vary from three to ten minutes, or even longer.

The illuminating apparatus here shown consists of a lantern which not only moves together with the Microscope on the central sliding-board, but can be moved independently to or from the Microscope, and be clamped with screws at the requisite distance for obtaining the best illumination. The lime cylinders should be of the best quality, of hard lime. Oxygen should be supplied preferably in a compressed state in iron bottles. Not only are the bottles much less cumbrous than the bags, but a small quantity of gas can be used, and the residue left for an indefinite time, and is always at hand to be turned on when required. On the other hand, the retention of unused gas in the bags is liable to cause their corrosion, owing to the impurities which are carried over in the manufacture of the oxygen.

A half-plate camera is employed, which is mounted upon a sliding platform. This admits of the camera being pushed up to the Microscope when it is in the long axis of the apparatus, so as to make a light-tight combination. The opening occupied in an ordinary camera by the lens, can be shut off by means of an internal shutter, which is opened and closed by turning a screw at the side of the camera. The dark-back is provided with plate-carriers, so that either half, quarter, or lantern-size plates can be employed. It is found convenient to have two or more dark-backs, so that several plates may be exposed without re-arranging the light for each exposure.

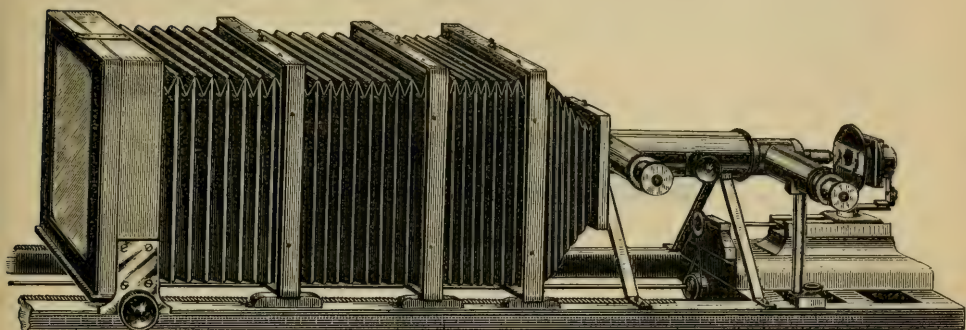
Rafter's "Professional Photo-Micro-Camera,"*—Mr. G. W. Rafter criticizes a statement of the Hon. J. D. Cox that he obtained the best results in photomicrography by using a No. 1 eye-piece in the Microscope and no other amplifier. In his view the use of an eye-piece causes not only great loss of light, but also great loss of distinctness in the image. He also condemns the use of the Zeiss projection eye-pieces, on the ground that "any process that necessitates the removal of one piece of apparatus and the substitution of another in its place is for high-power work fundamentally defective," the inevitable disturbance of apparatus in making such changes leading not only to loss of time, but usually to deterioration of the negative. The author considers that the use of the simpler optical combination of the adjustable achromatic amplifier for correcting microscopic objectives when they are required to be used for projection is on the whole preferable, and hence he included in a new camera which he recently devised an arrangement for adjusting the amplifier so that the best correction of the objective can be readily obtained. After a very full exposition of the optical principles involved, the camera is described as follows:—

"In order to get such ready means of adjusting the amplifier and to

* Rafter, G. W., 'On the use of the Amplifier, With observations on the Theory and Practice of Photomicrography, suggested by the design of a new Photo-micro-camera,' sep. repr. from Rochester (N. Y.) Odontographic Journal, viii. (1887) pp. 110-44 (14 figs.).

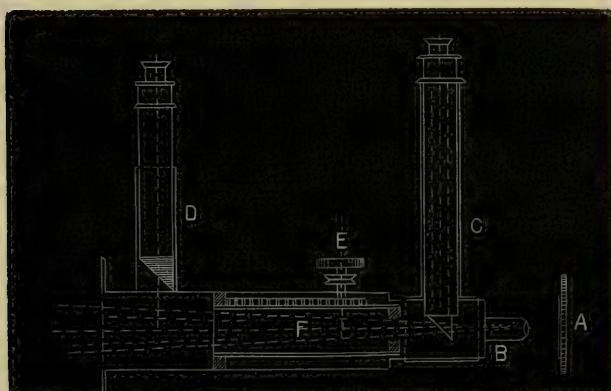
develope a photo-micro-camera which would answer all the demands which might be made upon it I have designed the apparatus shown in fig. 227. This is really a photo-micro-camera complete within itself, and not a Microscope and camera combined. I found early in my experience as a photomicrographer that one instrument could not be made to do the work

FIG. 227.



of two, and that it was only possible to use photography as a real aid to microscopical investigation by having photomicrographic apparatus which in addition to being always ready, also possessed the quality of easy adjustment to any and all kinds of work. The present design possesses not only all these qualities, but it can also be furnished at a price quite

FIG. 228.



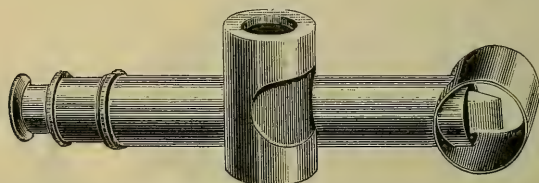
within the reach of any person really desiring such an aid to scientific investigation.

A reference to fig. 228 in conjunction with fig. 227 will show the novel points.

A in fig. 228 is the stage, B is a nose-piece which carries the objective

and also a removable collar carrying the tube C, which is supported by a removable pillar shown in fig. 227. Inside the tube C is a second tube made to work back and forth very easily, and carrying at its lower end a right-angle prism set for total reflection. This tube is of such a length as to give, when in position for receiving the image from the objective through the prism, a length of 10 in. measured along the optical axis. The eye-piece in the outer end has cross-hairs set in the diaphragm, so adjusted in relation to the prism at the other end as to correspond with cross lines on the ground glass of the camera screen. The tube C, therefore, gives

FIG. 229.



the opportunity to examine the object under the conditions of microscopic vision, and with the cross-hairs in the eye-piece farther enables the operator to exactly centre the object on the screen.

F is an adjustable tube carrying within it a second tube, which may be slid back and forth. This interior sliding tube has an adapter at the front end, into which an amplifier may be screwed, and the whole racked back and forth by the pinion E, which also carries between the thumb-screw and the body a pulley over which a band can be passed for working the amplifier from the rear of the camera screen.

This inner tube also has a graduation on the side, in order to facilitate recording the proper position of the amplifier for various extensions of the screen.

In working with high powers where it is desirable to use the amplifier, the objective is set to normal working distance by observing the object through the tube C. The operator then, from the rear of the camera, by use of the band over the pulley at E, racks the amplifier to such a position as to give a sharp and distinct image on the ground glass, the objective in the meantime remaining undisturbed. It is of course understood that after having adjusted the objective to normal working distance the inner tube at C, carrying the prism and eye-piece, has been sufficiently withdrawn to allow the rays of light to pass unobstructed to the camera screen. This gives us almost instantly the conditions which have been shown above to be necessary for production of the highest results, and with this apparatus the most difficult tests are easily photographed.

When working with low powers the amplifier is not essential for the production of sharp images, and the tube C and nose-piece B are removed by simply slipping off the collar from the nose-piece, and unscrewing the nose-piece from the body, an operation which may be performed in a moment. Fig. 229 shows these parts when detached.

After removing B and C, the inner tube F is drawn forward so that the front end of it occupies approximately the position of B when in place, and the objective is screwed into the adapter in the end of said tube F, which in high-power work carries the amplifier.

D is a second tube back of F, with prism and eye-piece with cross-wires, precisely as in C. With this tube the object is examined and centered on the ground glass, as above described, for work with C. After such centering

the focusing is completed either by use of the band passing over the pulley at E, or by use of the long rod and fine-adjustment to be described below. The inner tube at D is shown as drawn back in such position as to allow the rays of light to pass unobstructed to the screen.

The camera itself has both bellows and base made in sections, each two feet in length. The sections of the bellows can be readily removed, or additional sections inserted, when greater extension is required. . . .

The plate and screen-holder is racked back and forth as clearly shown in fig.

On the side of the base is a graduation in feet, tenths and hundredths of a foot, which enables one to record positions of the screen for producing given magnifications easily.

The fine motion is communicated to the stage, and not to the objective, as is shown in fig. 227.

The camera, as shown in the fig., admits of an extension of 8 feet, and sections of base and bellows similar to those above described can be added, extending it almost indefinitely. The extension above given will, however, answer all ordinary demands.

In its present form the camera takes a $6\frac{1}{2} \times 8\frac{1}{2}$ plate, and all sizes less than that down to the smallest.

This apparatus has been specially designed with reference to doing photomicrographic work of a high character with the greatest possible economy of time. It is for this purpose that the second prism-tube has been added specially for low-power work without the amplifier, and I have no difficulty in making with this camera a half dozen negatives in an evening, when working with lamplight and the amplifier, or from eight to ten in the same time when working with low powers and without the amplifier, in each case doing my own developing. In working by sunlight, where much shorter exposures are required, the same length of time gives an additional amount of work.

In case one has an extra Microscope, the new apparatus for working the amplifier may be adapted to it at moderate expense, and, by construction of the bellows and extension arrangements as above described, the more important advantages of the camera gained.

I desire, however, to put myself on record as opposed to the combination instruments—those which are to be used for microscopy ordinarily, but which can be, when one has something worth photographing, for the time being transformed into a camera. The trouble with all such instruments is, they have in general failed to do satisfactory photomicrographic work.

For rapid work the camera should be placed on a shelf on one side of the room at such a height as to bring the horizontal prism-tubes level with the operator's eye. The position of the camera at one side of the room insures economy of space, and does away with the objection that the camera, even though of considerable size, takes up much room.

When it is intended to work by lamplight only it will not matter which side of the room is used for this purpose, and the operator may locate the camera to suit his surroundings; care must be taken, however, to have the graduation of the base on the side away from the wall. If one has plenty of room, the best arrangement would of course be to erect a shelf on horses in the middle of the room, so that the camera is accessible on both sides.

When it is intended to work by sunlight the camera must of necessity be at either the east or west side of a room with an exposure to the south, or when economy of space is of no importance, it can be conveniently placed in front of a window facing the south, in which may be fitted up the necessary arrangements for heliostat, mirrors, or condensing lens.

In any case, the surroundings will decide to some extent just what arrangement will be adopted.

The following are, so far as I know, the new features embodied in this camera :—

(1) The application of specific appliances for moving the amplifier back and forth, in order to find by trial, for any given extension of the camera, the best position of the amplifier for projecting the image upon the screen.

(2) The application of two horizontal prism-tubes, one for use with high powers and the amplifier, and the other for use with low powers without the amplifier.

(3) The detachable nose-piece and prism-tube for high powers only (fig. 228).

(4) The cross wires in the diaphragm of the eye-piece of the prism-tube, giving an immediate centering of the object on the camera screen.

(5) The making of the bellows in sections in such manner as to admit of their easy removal or of a ready indefinite extension.

(6) The making of the base in sections in combination with the focusing-rod, connected by an automatic coupling.

(7) The plate-holder, which admits of all sizes of plates, from the maximum of $6\frac{1}{2} \times 8\frac{1}{2}$ to the smallest, without the use of kits.

Another new feature, which, however, is not specifically claimed, is this : If one has a prejudice in favour of photographing with an eye-piece, or if, from motives of economy, one desires to dispense with the amplifier and work with the eye-piece, this may be done by simply inserting an eye-piece in the back end of the amplifier-tube. For so working, an adjustable nose-piece for carrying the objective without the high power prism-tube may be furnished, thus dispensing with one of the prism-tubes, which, however, can be added at any time by change of nose-pieces. The object can be still centered by the posterior prism-tube, which is permanently fixed to the body, and the projection of a sharp image upon the screen completed by moving the eye-piece with the pinion E (fig. 228).

The general claim is made, therefore, that this camera embodies more nearly all the conditions necessary for rapid and successful work than anything heretofore produced. I have no doubt, however, but that a very considerable improvement can still be made, and confidently expect, in view of the great interest now centering in photomicrographic work, that the next few years will develop such improvements."

It should be added that the author is not unmindful of his obligations to the photomicrographic Microscope of Nachet,* as he says, "The novel point of this camera is the use of the prism-tube somewhat as I have arranged it in my camera, and I very willingly acknowledge my indebtedness to M. Nachet for the suggestion. He has, however, used the tube vertical, and as a fixed part of the apparatus."

Hartnack's Cupro-ammonia Cell.†—Dr. E. Hartnack has ingeniously modified the form of this cell, so as to enable a thicker or thinner stratum of the blue fluid to be used at pleasure in photomicrography, thus varying the illumination according to the requirements of the particular object.

The apparatus consists of two ebonite rings, each closed on one side by a parallel plate of glass. The rings slide in one another (hermetically), and when pushed together part of the liquid is forced into a lateral reservoir, from which it is drawn again when the rings are separated.

* See this Journal, 1886, p. 840.

† Journ. de Microgr., ix. (1885) p. 366.

COX, C. F.—Remarks on Photomicrography.

[Principally as to letting the negatives alone after they are taken.]

Journ. New York. Micr. Soc., 1887, pp. 18-9.

H., G. M.—A simple Photographic and Photomicrographic Apparatus.

Engl. Mech., XLV. (1887) p. 503 (12 figs.), from *Scientific American*.

KING, Y. M.—The Photomicrography of Histological Subjects.

New York Med. Journ., II. (1887) pp. 7-11.

Photo-Microscopy. I, II.

Charterhouse Phot. Art. Journ., I. (1887) pp. 2-4.

ROUX, E.—La Photographie appliquée à l'étude des microbes. (Photography applied to the study of microbes.)

Ann. de l'Institut Pasteur, 1887, pp. 209-25.

(5) Microscopical Optics and Manipulation.

Limit of Visibility.—In his Presidential Address at the Manchester Meeting of the British Association, Sir H. Roscoe appears to have fallen into a not unimportant mistake with regard to the smallest dimensions which can be distinguished by the Microscope.

In dealing with atoms he said:—

“Next let us ask what light the research of the last fifty years has thrown on the Daltonian atoms: first, as regards their size; secondly, in respect to their indivisibility and mutual relationships; and, thirdly, as regards their motions.

As regards the size and shape of the atoms, Dalton offered no opinion, for he had no experimental grounds on which to form it, believing that they were inconceivably small and altogether beyond the grasp of our senses aided by the most powerful appliances of art. . . .

But modern research has accomplished, as regards the size of the atom, at any rate to a certain extent, what Dalton regarded as impossible. Thus, in 1865, Loschmidt, of Vienna, came to the conclusion that the diameter of an atom of oxygen or nitrogen was $1/10,000,000$ part of a centimetre. *With the highest known magnifying power we can distinguish the $1/40,000$ part of a centimetre*; if now we imagine a cubic box each of whose sides has the above length, such a box when filled with air will contain from 60 to 100 millions of atoms of oxygen and nitrogen. A few years later William Thomson extended the methods of atomic measurement, and came to the conclusion that the distance between the centres of contiguous molecules is less than $1/5,000,000$ and greater than $1/1000,000,000$ of a centimetre; or, to put it in language more suited to the ordinary mind, Thomson asks us to imagine a drop of water magnified up to the size of the earth, and tells us that the coarseness of the graining of such a mass would be something between a heap of small shot and a heap of cricket-balls. Or, again, to take Clifford's illustration, you know that our best Microscopes magnify from 6000-8000 times; a Microscope which would magnify that result as much again would show the molecular structure of water. Or again, to put it in another form, if we suppose that the minutest organism we can now see were provided with equally powerful Microscopes, these beings would be able to see the atoms.”*

Microscopists will readily recognize that the $1/40,000$ of a centimetre—which is approximately $1/100,000$ of an inch—is vastly too low a figure, which should be at least 5 times smaller. Dr. Royston-Pigott claims to have seen the $1/1,000,000$ of an inch, but, whether he has or not, it is certain that the $1/500,000$ of an inch has been distinctly recognized. Moreover, Sir Henry himself, as will be seen, states that a power of 8000 times is attainable “with our best Microscopes”; multiply $1/100,000$ in.

* Cf. *Nature*, xxxvi. (1887) p. 417.

by 8000, and we get nearly $1/12$ in., which it is obviously absurd to put as the limit of visibility in the microscopic image.

The difference does not affect Sir H. Roscoe's argument, for the capacity to see even the $1/1,000,000$ of an inch would still leave us far from the point when atoms would be visible, but we call attention to his statement because, coming from so high an authority as a President of the British Association, it may give rise to a serious misapprehension as to the powers of the Microscope of the present day.

Heath's 'Geometrical Optics.'*—Measure of the Aperture of the Microscope.—Dr. R. S. Heath's book is, we believe, the first English treatise on optics in which aperture is dealt with. The following is the author's treatment of the subject:—

It has been shown that the brightness of an image given by a Microscope is determined by the formula

$$I = I_0 \frac{\lambda^2}{p^2} \cdot \frac{u^2 \sin^2 a}{m^2},$$

where λ is the conventional image distance, p the radius of the pupil of the eye, m the magnifying power, and a the divergence of the cone of rays proceeding from the object in a medium whose refractive index is u . Thus for an instrument of given magnifying power,

$$I \propto (u \sin a)^2,$$

and accordingly, $u \sin a$ may be taken to be the numerical measure of the aperture.

This measure of the aperture may be expressed in terms of the focal length of the objective, and diameter of the pencil passing through it. The diameter of the pencil as it passes through the object varies from the first to the last surface. We shall suppose that the diameter is taken at the back surface of the objective as the pencil emerges from it. This will be so close to the second principal focus of the objective in microscopic objectives of the ordinary type of construction, that the difference in the distance may be disregarded. We shall therefore suppose that b is the semi-diameter of the pencil at the second focal plane of the objective, and that f is the focal length of the objective. Let u' be the distance of the image from the second principal focus; then, using the ordinary notation,

$$\frac{\beta'}{\beta} = - \frac{u'}{f}.$$

Also by Helmholtz's theorem, we have

$$u \beta \sin a = u' \beta' \sin a',$$

and therefore

$$\begin{aligned} u \sin a &= u' \frac{\beta'}{\beta} \sin a' \\ &= - \frac{u'}{f} u' \sin a'. \end{aligned}$$

The angle a' is always very small in Microscopes, never exceeding a few degrees, and therefore $u' \sin a'$ will not differ sensibly from $u' \tan a'$. But $b = -u' \tan a'$, and therefore

$$u \sin a = \frac{u' b}{f}.$$

* Heath, R. S., 'A Treatise on Geometrical Optics,' xvii. and 356 pp., figs., 8vo, Cambridge, 1887, pp. 294-6.

The last image is always formed in air, so that $u' = 1$, and therefore finally

$$u \sin \alpha = \frac{b}{f}.$$

This numerical measure of the aperture may be justified by general reasoning. Other things being equal, it is clear that the numerical measure of the aperture ought to vary as the diameter of the pencil. Next suppose we have objectives of the same diameter of opening, but of different focal lengths. Imagine rays traced backwards through the two objectives in succession from the same object. The incident rays are nearly parallel, and since the openings of the objectives are the same, they will admit backwards the same number of rays. But these rays will be concentrated to a smaller area by the lens of shorter focal length than by the other, the linear dimensions of the areas varying as the focal lengths, but their brightness being the same. Reverting to the original arrangement of the instrument, the objective of shorter focal length will admit the same number of rays from the smaller area as the other will admit from the larger area. The real aperture of the former is therefore greater than the other in the inverse ratio of their focal lengths.

The value b/f is independent of the medium in which the object is placed; it is the same for air, water, balsam, or any other immersion system. A numerical aperture *unity* would correspond to an incident cone of rays in air whose vertical angle is 180° , while with homogeneous immersion the same aperture would correspond to a cone of angle $82^\circ 17'$; and with modern objectives the apertures reach 1.40 , and sometimes more than this.

The magnifying power of an objective may be measured for a definite position of the image by projecting the image of a stage micrometer upon an eye-piece micrometer. And then we can find the numerical aperture of the objective by means of the formula

$$u \sin \alpha = \frac{m b}{u'}.$$

An auxiliary Microscope may be focused to the focal plane, and the linear diameter $2b$ of the emergent pencil measured there; then we have only to measure u' , the distance of the focal plane from the image to which m refers, and we have the means of finding the value of $u \sin \alpha$.

Conversely, if we know the numerical aperture, the focal length of the object-glass may easily be measured; for using the formula

$$u \sin \alpha = \frac{b}{f},$$

we have only to measure micrometrically the diameter $2b$ of the pencil as it emerges at the principal focal plane.

Binocular Vision with the Microscope.—It will be remembered that Prof. Abbe a few years back startled microscopists by the statement* that the action of the binocular Microscope was quite different from ordinary vision, a view which produced an energetic protest from the late Dr. Carpenter,† who had not, however, apprehended the point of Prof. Abbe's argument, which was left untouched. In the last volume of the *Encyclopædia Britannica*‡ we observe that Prof. J. G. M'Kendrick (under the head of "Stereoscope") very tersely sums up the result of the controversy (if it can be so called) as follows:—

* See this Journal, 1884, p. 20.

† Ibid., p. 486.

‡ Ency. Brit., xxii. (9th ed. 1887) p. 541.

"Prof. Abbe shows, however, that 'oblique vision in the Microscope is entirely different from that in ordinary vision, inasmuch as there is no perspective, so that we have no longer the dissimilarity which is the basis of the ordinary stereoscopic effect, but an essentially different mode of dissimilarity between the two pictures.' In the Microscope there is no perspective foreshortening. There is no difference in the outline of an object viewed under the Microscope by an axial or by an oblique pencil. There is simply a lateral displacement of the image—an entirely different phenomenon to that which occurs in non-microscopic vision. Thus, whilst the mode of formation of dissimilar pictures in the binocular Microscope is different from the production of ordinary stereoscopic pictures, the brain mechanism by which they are so fused as to give rise to sensations of solidity, depth, and perspective, is the same."

HANKS, H.—Errors likely to occur in Microscopical Observations.

[Abstract only]. "The hemispherical bosses upon certain diatoms are persistently seen by some as cup-shaped depressions or concavities."

Report of Proceedings of San Francisco Micr. Soc., July 13th, 1887.

Magnifying-power of Objectives, Measurement of.

[Further letters by F. R. Brokenshire and F. J. George.]

Engl. Mech., XLV. (1887) pp. 540, 561-2.

MARSHALL, W. P.—On the measurement of the magnifying power of Microscope Objectives; with exhibition of 1/25 in. water-immersion objective of Powell and Lealand.

[Camera lucida method.]

Midl. Natural., X. (1887) pp. 226-8.

POLI, A.—I recenti progressi nella Teoria del Microscopio. (Recent progress in the theory of the Microscope.)

25 pp. 8vo, Firenze, 1887. (Sep. repr. from *Rivista Scientifico-Industriale.*)

ROYSTON-PIGOTT, G. W.—Microscopical Advances. XXII., XXIII.

[Diffraction ancient and modern—Insects' scales.]

Engl. Mech., XLV. (1887) pp. 547-8; XLVI. (1887) pp. 1-2 (3 figs.).

(6) Miscellaneous.

Royal Microscopical Society of the Sandwich Islands.—In 1878* we referred to the establishment of this Society by King Kalakua, a Society which we gather has now ceased to exist. This would appear to be the case from a report of a recent meeting of the San Francisco Microscopical Society, where Prof. F. L. Clarke, of Honolulu, is stated to have "given an interesting account of microscopical matters in the Hawaiian Islands," and in the course of which he "narrated the career of the Microscopical Society which once existed there." The king is now desirous to perfect arrangements for the systematic exploration and study of the natural history of the islands, and in pursuance of this plan the San Francisco Society is to be plentifully supplied with collections of objects suitable for microscopical investigation, and it has been "selected as an agent for the distribution of such material to societies with similar aims in other parts of the world."

Curiosities of Microscopical Literature.—A recent paper† on "Mounting Media, so far as they relate to diatoms," may certainly be ranked amongst the curiosities of microscopical literature, and we are at a loss to understand how it came to be printed. We quote below in full that part of the paper which is headed "Fluids" and it will be seen that the author begins by the statement that he "cannot too emphatically condemn" certain media, such as biniodide of mercury and iodide of potassium, "simply from the fact that the diatoms will not remain on the cover-glass, but must "necessarily fall to the bottom of the cell." This, to begin with, was a most astounding statement to make after all that has been said on the subject,

* See this Journal, 1878, p. 152.

† Journ. Quek. Micr. Club, iii. (1887) pp. 108-14.

but it is made even more surprising when we come upon the statement lower down in the paper, "I have never seen a slide of diatoms mounted "in biniodide of mercury and iodide of potassium," so that the cannot-be-too-emphatic condemnation of the medium with which the author began was not founded on any practical experience whatever.

The climax, however, is not yet reached, for in a footnote the author, it will be seen, states that he has now learnt that the diatoms will *not* fall to the bottom of the cell, as he had asserted, but will float and press upwards against the cover-glass!

The following is the paragraph:—

"*Fluids*.—Although certain of these media, such as biniodide of mercury with iodide of potassium, as well as oil of cassia, can be obtained with fairly high refractive indices, yet I cannot too emphatically condemn them for use with the higher powers of the Microscope, simply from the fact that the diatoms will not remain on the cover-glass, but must necessarily fall to the bottom of the cell, which consequently must be very shallow, otherwise the diatoms will be beyond the focus of the objective. With shallow cells in fluid mounts the diatoms can easily get crushed on cleaning the cover-glasses. If it were not for these fatal objections, I should be disposed to regard oil of cassia very favourably as a mounting medium, as these essential oils give great brilliancy; but whether they can be effectually sealed for a permanency I cannot say. I once mounted a slide in oil of cloves, and it remained perfect for some considerable time, but eventually a bubble made its appearance. I have never seen a slide of diatoms mounted in biniodide of mercury and iodide of potassium, and am inclined to think that this medium is very little used.

[Since writing the above I have learnt, with respect to the solution of biniodide of mercury and iodide of potassium, that the medium is of such high specific gravity—viz. 3.02—that any diatoms which may chance to become detached will float in the fluid and press upwards against the covering-glass, instead of falling to the bottom of the cell.]

The paragraph headed "Canada Balsam" is, however, still more wonderful than the preceding, as the author makes this statement:—"The only "objection, to my mind, against this medium is that its refractive index "is not sufficiently high for the new immersion lenses"! Let us put the refractive index of Canada balsam at its lowest limit and call it 1.52, where are these new immersion lenses which, according to the author, have a higher "refractive index"? The simple explanation no doubt is that the author was quite unaware of the principle on which the use of media of high refractive index depends, but that does not make it any the less lamentable that such matter should have been presented in a scientific paper to a Microscopical Society at the present day.

"A QUEKETT CLUB-MAN."—My Microscope and some Objects from my Cabinet. A simple introduction to the study of the "infinitely little."

78 pp., 5 figs., 8vo, London, 1887.

American Society of Microscopists—Pittsburgh Meeting.

Amer. Mon. Micr. Journ., VIII. (1887) pp. 156-7.

Microscope, VII. (1887) pp. 248-50, 269-74.

DALLINGER, W. H.—The Marvels of Microscopy.

[Presidential Address to Devonshire Association for the Advancement of Science, Literature, and Art.]

Western Daily Mercury, 17th July, 1887.

Mayall, J., jun.—Conférences sur le Microscope. (Lectures on the Microscope.)

(Contd.)

[Transl. of the Cantor Lectures.]

Journ. de Microgr., XI. (1887) pp. 240-6 (1 fig.), 269-75 (2 figs.), 335-41 (9 figs.).

β. Technique.***(1) Collecting Objects, including Culture Processes.**

Solid Medium for the Culture of Micro-organisms.†—Dr. Schenk recommends the outer layers of the white of the eggs of marsh fowl and waders as a suitable medium for breeding micro-organisms, on account of its great transparency when coagulated at temperatures of 65°–70° C. This albumen can be diluted with a fourth of its volume of water before coagulation, and can be mixed with salt, dextrin flour, sugar, glycerin, &c. Of course discontinuous sterilization must be employed as usual.

New kind of solid Blood-serum—Blood-serum Plates.‡—Dr. P. G. Unna states that by the addition of peroxide of hydrogen and carbonate of soda to blood-serum he produces a fluid which coagulates at a high temperature, can be easily sterilized, and preserves its transparency and suitability as a nutritive medium for micro-organisms.

The procedure is as follows:—To a small quantity of calf's blood-serum hydrogen peroxide is added drop by drop, and the mass kept agitated until the brownish-yellow mixture clears up and assumes quite a white colour. The quantity of peroxide of hydrogen added is equal to about half the volume of the serum, and as the commercial fluid is acid, a 2 per cent. solution of sodium carbonate must be added until a slight alkalinity is perceived. It is then filtered until quite clear. The serum is then solidified in Koch's apparatus at a temperature of 90°–120°, according as less or more peroxide and carbonate have been added. The condensation water having been poured off, discontinuous sterilization is continued until sufficient.

For serum plates the author adds 10 per cent. gelatin or 6 per cent. agar-agar to the mixture if the blood-serum have lost its susceptibility to coagulate owing to an excessive addition of alkali.

Preserving cultivations made by Koch's plate method.§—Dr. C. Garré removes a piece of gelatin 2–5 sq. cm. in size, and in which is the colony to be transplanted to a slide, with a thin moistened knife. Should the gelatin layer roll up, it is to be immersed in water, and then the piece is dried under a bell-jar or in a sulphuric acid apparatus until it is reduced to one-half or one-third its original volume. A drop of glycerin-gelatin fluidified at a gentle heat is then added in order to prevent the gelatin tablet from crumpling up. The cover-glass is next imposed.

This manipulation must be carefully carried out, otherwise the colonies, especially if luxuriant, might be damaged. As the drying stops development the organisms may be fixed in any stage of their existence; the colonies do not undergo any change with keeping, and, if desired, by merely removing the cover, they are always available for cover preparations or pure cultivation.

Modification of Koch's plate method for the isolation and quantitative determination of Micro-organisms.||—Dr. E. Esmarch's modification simply consists in the use of a test-tube, the interior of which is covered with a layer of some nutritive medium, e. g. gelatin. The test-tube, the mouth being covered with a rubber cap, is laid horizontally on a vessel filled with ice-cold water, and turned round with the hands until the gelatin has set.

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Allgemein. Wiener Med. Ztg., xxxii. (1887) p. 214.

‡ Monatshefte f. pract. Dermatologie, v. (1886) No. 9.

§ Fortschr. d. Med., iv. (1886) p. 392.

|| Zeitschr. f. Hygiene, i. (1886) p. 293.

When developed the colonies may be examined with low powers, and even photographed. Individual colonies may also be taken out for further examination. The estimation of the number of germs is made in the ordinary way. The enumeration of the colonies may be made by placing a piece of paper divided into parts of a centimetre and multiplying the number in a given square by the superficies, or a special apparatus devised by the author may be used.

If instead of gelatin agar be desired, it is advisable to add to each 10 cm. of agar 2 or 3 drops of a neutral sterilized solution of gum arabic or isinglass. If anaerobic bacteria are to be studied, the central space must be filled with gelatin while the tube is still in the ice-water.

The advantages of this method over the ordinary plate cultivation are its safety against impurities, the simplicity and rapidity of its execution, the small amount of apparatus, and its facility of transport.

Bacteriological experiments with coloured nutrient media.*—It is well known, says Dr. A. Spina, that indigo-blue turns white when acted on by reducing agents, and recovers its former colour on exposure to the air. It was this property which induced the author to make some experiments in order to ascertain if it could not be made available for cultivation research.

A test-tube was half filled with the following solution:—0.5 phosphate of potash, 0.5 sulphate of magnesia, 1.0 tartrate of ammonia, and 100 distilled water; and this stained with two or three drops of a watery solution of sulphindigotate of soda. The coloured fluid was inoculated with some drops of putrid blood, the test-tube plugged with cotton wool, and incubated at 38°. After three or four days the fluid was decolorized, and the bacteria much augmented in number. The nutrient medium acquired the appearance of thin milk, and only on the surface was a blue layer evident. If the tube was shaken the fluid became blue again, and white when put in the incubator again. Methylen-blue behaves in a manner quite similar.

The objection might be raised that the loss of oxygen was due, not to the bacteria, but to the nutrient medium. That this is not the case the following experiments prove:—(a) If a test-tube filled with the coloured medium be inoculated, and after having been decolorized in the incubator, and then sterilized, it rapidly becomes blue, but no further decoloration ensues, although it remains several days in the incubator. (b) If a test-tube filled with the coloured medium, and having been sterilized, be kept for a week at a temperature of 38°, no decoloration of the fluid takes place. Experiment also shows that the loss of oxygen was not produced by means of the chemical products of the proliferating bacteria. It was remarked before that shaking or warming restored to the decolorized fluid its original hue. This is explicable only on the assumption that the white methylen-blue or indigo takes up oxygen, and the correctness of this view is shown by the following experiment:—A glass tube filled with the stained and inoculated fluid is melted up at the open end after all air has been expelled, and decolorized in the incubator. In this case shaking will not bring back the blue colour.

From fluid the author passed to solid media, of which he employed two—(1) meat-peptone-gelatin and (2) meat-peptone-agar. A weak solution of the former, stained and inoculated, and kept at a temperature of 22°, became decolorized below the colony in about three days. (The bacteria used were developed on potato, and from the air, but no name is given.) In a few days the decolorized column was quite large, but at the surface the layer in con-

* Centralbl. f. Bacteriol. u. Parasitenk., ii. (1887) pp. 71-5.

tact with air still blue. When the tube was shaken up, the whole of the fluidified gelatin became blue. The return of the blue obviously depended on the inclosed air, for it disappears almost completely if the fluid be kept from contact with air by pouring oil over it. (2) Meat-peptone-agar possesses an advantage over the foregoing in that it does not reduce the methylen-blue. For staining, one-third of a tube full of this medium with two drops of a watery sterilized concentrated solution of methylen-blue were employed. After sterilization and inoculation with the potato-grown bacillus, there appears, after about three days at a temperature of 22°, a decoloration of the superficial layers of the agar, and this in six days amounts to about 1.5 cm., while the colony itself seems slightly blue. The loss of colour proceeds more rapidly than the growth of the vegetation, and the decolorized gelatin is, as is shown by microscopical examination and inoculation, free from bacteria.

Numerous bacteria were found to be incapable of reducing either of the dyes, and the author believes from this that he has hit upon a way of ascertaining certain chemical relations between bacteria and nutrient media.

HEYDENREICH, L.—Sterilisation mittels des Dampfkochtopf (Papin'scher Topf) für bacteriologische Zwecke. (Sterilization by the steam digester (Papin's digester) for bacteriological purposes.)

[The author finds that a nutrient fluid placed close to the source of heat, in the water, quickly acquires the surrounding temperature of the superheated steam, if only the walls of the glass vessels be not too thick, the air as far as possible removed, and the quantity of the nutrient fluid not too great. And also that as no bacteria or fungi can withstand steam at a temperature of 120° for 5–10 minutes, it may therefore be considered that 15–20 cc. of fluid is safely sterilized if the thermometer keeps at 120° for 5–10 minutes, and if the air has been previously carefully removed (the manometer marking two atmospheres.)]

Zeitschr. f. Wiss. Mikr., IV. (1887) pp. 1–24 (4 figs.).

KELLICOTT, D. S.—Notice of some Fresh-water Infusoria, with remarks on collecting and preserving these delicate animals.

Microscope, VII. (1887) pp. 225–33 (4 figs.).

NASMYTH, T. G.—Methods for cultivation of micro-organisms from water.

Sanit. Record, 1887–8, pp. 16–9.

ROHRBECK, H.—Ueber störende Einflüsse auf das Constanthalten der Temperatur bei Vegetationsapparaten und über einen neuen Thermostaten. (On disturbing influences on the constancy of the temperature in culture-apparatus, and on a new thermostat.)

Centralbl. f. Bacteriol. u. Parasitenk., II. (1887) pp. 262–5, 286–90 (3 figs.).

VIGNAL, W.—Sur un moyen d'isolation et de culture des microbes anaérobies. (On a method of isolation and culture for anaerobic microbes.)

Ann. Inst. Pasteur, 1887, pp. 358–9.

WILFARTH, H.—Ueber eine Modification der bacteriologischen Plattenculturen. (On a modification of the bacteriological plate-cultures.)

Deutsche Med. Wochenschr., 1887, pp. 618–9.

ZÄSLEIN, T.—Ueber den praktischen Nutzen der Koch'schen Plattenculturen in der Choleraepidemie des Jahres 1886 in Genua. (On the practical use of Koch's plate-cultures in the Genoa cholera epidemic of 1886.)

Deutsche Medicinische Ztg., 1887, pp. 389–91.

(2) Preparing Objects.

Methods for killing Invertebrata.*—For the preservation of animals, Prof. F. E. Schultze points out, it is desirable that they should seem as lifelike as is possible, or that no changes should occur to prevent them from being useful for fine microscopical work. Care must be taken to fix the animal in the extended condition, and to prevent the tendency to contrac-

* *Tageblatt 59 Versamml. Deutscher Naturf. u. Aerzte*, 1886, pp. 411–4. Cf. *Biol. Centralbl.*, vi. (1887) pp. 760–4.

tion. To effect this two methods are in vogue; the one acts with rapidity sufficient to prevent contraction, the other kills slowly by means of some paralyzing medium. Absolute alcohol, osmic acid, sublimate solution, chromic acid, and other mineral acids are agents of the rapid process.

Paralysis is produced by slow cooling, or gradual warming, or even by immersion in boiling water; but good service is rendered by alcohol chloroform in watery solution or vapour, sulphuric ether, prussic acid, carbonic acid, atropin, nicotin, strychnin, chloral hydrate, cocain. As suitable reagents for some of the divisions of the Invertebrata, the following are recommended:—

Rhizopoda.—For rapid fixation, osmic acid, and after-treatment with picrocarmin, or absolute alcohol, sublimate, and chromic acid. Chinin in weak solution produces palsy of the protoplasm.

Infusoria.—For paralyzing ciliary action, chloroform, soda or seltzer water. For killing quickly, osmic acid, sublimate, absolute alcohol, or chloral hydrate. Keeping animals alive but paralysed, salt solution. Regulated compression under cover-glass for purposes of observation effected by melting away wax supports with heated needles.

Spongia and Cœlenterata.—For sponges no reliable method is known. For Hydromedusa, Scyphomedusa, and Ctenophora, the rapid action of osmic acid. At Naples, polyps are killed rapidly with success by a boiling mixture of equal parts of sublimate and acetic acid. With Siphonophora, paralyzing with chloral hydrate is excellent. For Pennatulida with large polyps the gradual addition of fresh water. For histological work, Anthozoa may be paralysed with chloral, but this, like cocain, sometimes gives rise to contraction and deformity. For museum specimens, Anthozoa should be killed suddenly as with glacial acetic acid.

Echinodermata.—Casting of the arms may be avoided by imbedding star-fish in sand. The colour of star-fishes may be retained by immersing them for about 6 hours in Wickersheimer's solution.

Worms.—Some alcohol poured on the surface of the water in which the worms are, or chloroform water, acts as a paralyzing agent. Warm solution of corrosive sublimate or picro-sulphuric acid. Nemertines remain extended in chloral hydrate, yet much depends on the degree of concentration of the paralyzing fluid. Sudden heating over the flame of a spirit-lamp kills Trematoda. For Polychæta, alcohol. It is very difficult to obtain Rotifera in the extended condition. Carbonic acid water, chloral hydrate, cocain, followed by hardening in osmic acid or cocain solution cooled in ice, all recommended. On Bryozoa the last named medium has the same effect; chloral is not always satisfactory for the marine forms.

Mollusca.—Hot water for fixation. For slugs, tobacco smoke or concentrated sublimate may be used. Chromic acid should be altogether avoided as it renders them too brittle.

Tunicata.—Large animals are killed by passing a glass tube into the two openings and then injecting glacial acetic acid, alcohol, or Kleinenberg's fluid. Small species may be killed by pouring some alcohol or Kleinenberg's fluid and spirit on the top of the water.

Influence of reagents on the Fertilization and Segmentation of the Animal Ovum.*—Drs. O. and R. Hertwig who have previously demonstrated that the ova of the sea-urchin became weakened by immersion in sea water, and therefore became more susceptible to hybridization or polyspermia, i.e. to the penetration of several spermatozoa, now discuss the

* *Jenaische Zeitschr. f. Naturwiss.*, xx. (1887) pp. 120-4 (7 pls.).

effect of various chemical reagents of higher temperature, and of mechanical injury on the ova of *Strongylocentrotus lividus*, and also the effect of external agents on the sperma.

(1) Ova before fertilization. (a) Nicotin. A mixture of one drop of concentrated nicotin solution with 100 grms. sea water acting for 3-5 minutes, or with 1000 grms. sea water acting for 10-15 minutes. By stronger solutions or by longer immersion the degree of over-fertilization can be increased. By immersion for one hour in a solution of 1:100 the ova were not killed. (b) Morphia hydrochlorate solutions of 0.1-0.2 per cent. must act for one hour. Solutions of 0.4-0.6 per cent. produced after 1/2-1/4 hour a few cases of polyspermia. (c) Strychnine. Solutions of 0.005 per cent. produced a notable influence in 10 minutes, a remarkable one in 20 minutes. Solutions of 0.1 per cent. in 5 minutes effected strong polyspermia; in solutions of 0.25 the ova died in 25-60 minutes. (d) Chloral hydrate. A 0.2 per cent. solution produced polyspermia in 4 1/2 hours, while a 0.5 per cent. solution did so in 5 minutes, but after 4 hours the ova did not seem susceptible of fertilization. (e) Chloroform (the eggs placed in watch-glasses filled with sea water were exposed to the vapour of chloroform under bell-jars). The ova died in 15-20 minutes, a shorter time produced polyspermia. Chloroform water (chloroform shaken up with sea-water) prevented fertilization, the membrane immediately separating from the ovum. (f) Cocain. Solutions of 0.025 and 0.05 per cent. produced polyspermia in 5 minutes. A longer action weakened the ova too much. (g) Chinium sulfuricum. A solution of 0.005 per cent. produced perfect polyspermia in 75 minutes; in a shorter time the action was correspondingly less. A solution of 0.05 per cent. produced in 10 minutes and still more so in 15 minutes, very considerable polyspermia.

(2) Sperma before fertilization. (a) Nicotin. In solutions ten times as strong as used for ova the spermatozoa were mobile and quite fertile after two hours. (b) Chloral hydrate. In 0.5 per cent. solution motion ceased in 5 minutes, but returned on addition of fresh sea water even after 35 minutes' action of the solution, and were fertile. (c) Chinin. A 0.05 per cent. solution produced diminution after 5 minutes, and in 35 minutes cessation of movement. When the water was changed the motion only returned slowly and with imperfect fertilization of ova. (d) Strychnine. A 0.05 per cent. solution had a retarding influence after acting for 3 hours. (e) Morphia. A 0.5 per cent. solution seemed to have no influence. Fertilization was normal after 3/4 hour.

(3) Influence of chemical agents on the course of fertilization. Chinin and chloral diminished the radiation appearances in the protoplasm considerably, and hence inhibited the progress of the internal fertilization appearances. (a) The authors immersed the fertilized eggs for 10 minutes in a 0.5 per cent. chloral solution. (1) 1 minute. (2) 1 1/2 minute. (3) 5 minutes. (4) 15 minutes, after fertilization, and then examined a part of the fresh or fixed material. Specimens from each of these four divisions were taken at intervals from 10 minutes to 5 hours after the action of the chloral. The general results did not quite coincide with the previous observations, one part being more, the rest less strongly affected by the reagents, while the changes in the nucleus and protoplasm were not impeded to a like extent.

(4) Effect of chemical reagents after fertilization. (a) Nicotin solution (1-100) after acting for 3/4 hour on fertilized eggs, no appreciable result. (b) 0.1 per cent. solution of nicotin acting for 10-60 minutes had only slight influence. (c) Morphia. A 0.1 and 0.6 solution had only a retarding action; and a 0.5 solution and a 0.4 acting for 30-60 minutes had a

similar effect. (d) Chinium sulfuricum in 0.05 per cent. solution acting for 20-30 minutes caused retrogression of the plasma radiation, and this was restored after immersion for a longer period. In 5 minutes the amphiaser underwent a retrogressive segmentation. Preserved material showed that an action of 20 minutes sufficed to prevent or destroy nuclear fission. (e) Chloral; in eggs treated with 0.5 per cent. solution for 15 minutes the radiation disappeared, and in 30-60 minutes small projections appeared on the surface. After $5\frac{1}{2}$ hours the ova lost their susceptibility to impregnation. (f) Cocain acted like chloral and chinium sulfuricum.

(5) Results of thermic action on the products of reproduction. (1) Eggs kept in sea water at a temperature of 31°C . (a) 10 minutes; penetration of spermatozoa abnormal and incomplete: after $1\frac{1}{4}$ hours no copulation of nuclei took place. (b) 20 minutes; greater part of the ova fertilized by two to three spermatozoa. In $2\frac{1}{2}$ hours segmentation began; somewhat impaired. (c) 45 minutes; fertilization, usually by three to four spermatozoa, sometimes by five, rarely by two (15 ova—56 sperms). (d) 60 minutes; fertilization by three to five spermatozoa, rarely by seven or eight: no segmentation observed. (e) 90 minutes; fertilization by three to four spermatozoa: no reaction of the female plasma. (2) Ova heated to 55°C . for 5 minutes were killed, drops of albumen separating out. (3) Heated to 50° , 47° , 45° , 42° , 41°C . for 5 minutes, no fertilization. (4) Heated to 39° , 37° , 36°C ., fertilization took place, no segmentation. (5) Heated to 34° , 32° , 31°C . for 5 minutes, fertilization and segmentation with subsequent "monster" formation.

(6) Effect of mechanical injuries. Ova shaken up in a test-tube half filled with sea water for 20-30 minutes. The gelatinous membrane separated from the yolk-sac. The otherwise undamaged ova were as a rule fertilized by one spermatozoon. Ruptured ova may be impregnated by several spermatozoa.

(7) Preservation. Eggs were killed in picro-acetic acid, carefully washed, and put in 75 per cent. spirit. Staining with lithium carmine or Grenacher's borax carmine (24 hours, extraction with 75 per cent. spirit acidulated with $1/2$ -1 per cent. hydrochloric acid). Finally absolute alcohol; then mixture of equal parts absolute alcohol and oil of cloves; evaporation of the alcohol (best under a bell-jar and with vessel filled with strong sulphuric acid close by) dammar or glycerin. Gradual transference from one reagent to another brought out the nuclear figures more clearly than when those operations were quickly performed.

Preparing Tendon-cells and Cells of the loose Subcutaneous Tissue.*—

Dr. A. Dogiel obtained very good preparations of tendon by placing rat's tail in Grenacher's alum-carmine for two or three hours, or still better, for a week or even a month. The tendon bundles swell up and become transparent, and the cells appear beautifully stained. The elastic fibres stand out very clearly. The same effect may be obtained if tendon be placed in a saturated solution of potash or ammonia alum, and afterwards staining with Grenacher's carmine, alum logwood, hæmatoxylin, eosin, &c. Mounted in glycerin, the preparations keep for a long time, but afterwards a slight decoloration takes place. Permanent preparations of tendon are better placed in spirit, then oil of cloves, wherein they are teased out, then dammar or balsam. For the subcutaneous tissue it is recommended to take a piece free from fat from the inguinal or abdominal region of a mammal, and having spread it out, to stain with a concentrated solution of fuchsin, diluted with an equal volume of water, and then stain under the cover-

* Anat. Anzeig., ii. (1887) pp. 139-42.

glass, where the preparation lies in half per cent. solution. For permanent preparations picrocarmine, glycerin.

Preparing Medullated Nerve-fibres.*—Dr. T. Boveri, when examining medullated nerve-fibres, used the sciatic nerve of the frog, which was treated in the following way.

The nerve, carefully cut out from a frog recently killed, was stretched out according to Ranvier's method, and placed for four hours in a half per cent. solution of hyperosmic acid. It was then washed in distilled water, and hardened in 90 per cent. spirit. Pieces of nerve about 6 mm. long were then stained in a concentrated solution of acid fuchsin for twenty-four hours, and afterwards treated for a similar time with absolute alcohol. For cutting, the object was imbedded in paraffin. The author found that osmic acid gave good results if the 1 or 0.5 per cent. acid had come into actual contact with the nerve-fibres. In practice the central fibres of a bundle were only partially affected by this reagent, so that the action of water preponderated over that of the osmic acid.

For treating nerves with silver the author indicates the following course:—(1) If a nerve be placed in a 1 per cent. solution of silver nitrate, to which an equal volume of 10 per cent. nitric acid be added, the silver reaction takes place, and the fibrillar structure of the axis cylinder is to a certain extent retained, so that a periaxial space does not arise, owing to shrinking of the axis cylinder. (2) Nerves freshly teased out and exposed to osmic acid vapour on a slide in a half dry state are treated with a dilute watery or alcoholic silver solution. In well-hardened fibres the silver reaction occurs almost at once.

It may be remarked here that a mixture of equal volumes of 1 per cent. silver solution and 1 per cent. osmic acid gives the same reaction on fresh tissues as the silver solution shows by itself; hence this mixture is especially suitable for demonstrating the boundary parts of cells, and also for preserving the elements at the same time.

Demonstrating Sharpey's Fibres.†—Dr. A. Kölliker had only poor results when examining Sharpey's fibres in thin sections of decalcified bones of adults in water or dilute spirit. Far superior were 5–10 per cent. salt solution, acetic acid of various strengths, oxalic acid, and strong hydrochloric acid. Of the stains the most satisfactory was indigo-carmin, by which Sharpey's fibres were stained red, the rest of the bone-tissue blue. A section of the bone cartilage, rendered transparent with concentrated acetic acid, is placed for a quarter to one minute in the undiluted stain; then, after having been carefully washed, mounted in glycerin or balsam. Lithia-carmin and, less so, safranin, stain the fibres and the rest of the bone substance differently. New solid green 3 B, tartrazin Victoria blue B, Victoria blue 4 R, auramin, hæmatoxylin, osmic acid, palladium chloride, picric acid, and fuchsin were without effect.

With the polariscope and crossed nicols Sharpey's fibres appear dark transversely and bright longitudinally; for this accurate vertical focusing is necessary. Elastic fibres, rendered evident by acetic acid, are dark longitudinally. They are to be distinguished from Sharpey's fibres by treating sections with acetic acid, oxalic acid, and hydrochloric acid, or by destroying them with strong cold caustic potash or soda, or by staining (the elastic fibres) with fuchsin or safranin.

In preparations obtained by grinding bone Sharpey's *tubules* contain air, and after the addition of turpentine oil and balsam stand out quite clearly

* Abh. K. Bayer. Akad. Wiss., xv. pp. 423–94 (2 pls.).

† Zeitschr. f. Wiss. Zool., xlv. (1886) pp. 644–80 (4 pls.).

(the fluid penetrates the bone-cells and canaliculi). But a short heating of thin plates is better. The author was able to distinguish Sharpey's fibres in the soft and uncalcified condition from those partially calcified.

Physiological Silvering of Elastic Tissue.*—Dr. A. Blaschko states that in the cutis of silver-workers there are frequently found, in places exposed to the light, blue-black spots, which are formed from the penetration of minute fragments of metallic silver into the skin. It is obvious the silver is dissolved in the skin, and separates out from the solution into very fine granules under the influence of light. This reduction of silver takes place in the living tissue, especially in the course of the elastic connective tissue, the fine fibrillations of which are thus rendered manifest.

Preparation of the Retina.†—Dr. P. Schiefferdecker finds the following mixture preferable to Ranvier's alcohol as an isolation medium for the retina:—Aqua destillata, 20 vol.; glycerin, 10 vol.; methyl alcohol, 1 vol.

The eye, cut up, or only the retina is placed in this fluid for several days. A small piece of the retina with some water is placed in a test-tube and shaken up. It is then emptied into a watch-glass and some drops of glycerin and of a cold saturated watery solution of picrocarminate of soda added. It is then stirred up with a needle and placed in a sulphuric acid drying apparatus. The red-stained retina elements are mounted in glycerin. As this method is not always successful, several preparations are necessary. For hardening, the author used Müller's fluid, chromic acid 1–600, and acetum pyrolignosum, one part to three parts distilled water. The latter is especially recommended. Eyes of small animals should be hardened in osmic acid or its vapour, and afterwards treated with Müller's fluid. These small eyes are best hardened before being opened.

Imbedding in celloidin. This must be allowed to soak in for some days, and the cover removed little by little. When the ether and alcohol have so far evaporated that the finger scarcely leaves an impression on the celloidin mass, 50 per cent. spirit is poured in and the mass taken out the next day, when it may be cut. The knife should always be kept wet with spirit. Paraffin imbedding alters the retinal elements, and osmic acid is to be avoided as it gives rise to deceptive appearances owing to precipitation.

Preparing the Mammalian Testis.‡—In investigating the mammalian testis, Herr C. Benda used the following reagents and methods.

For hardening purposes, he imitated Biondi in the almost exclusive use of Flemming's chromic-osmic-acetic mixture (1 per cent. chromic acid 7 vols., 2 per cent. osmic acid 2 vols., glacial acetic 0.3–0.5 gr.). Concentrated picric acid and sublimate also yielded very fair results. The imbedding, cutting, and fixing in albumen-glycerin were accomplished as usual. Staining was effected by a modification of Heidenhain's and Weigert's hæmatoxylin method. The sections remain twenty-four hours at about 40° C. in concentrated solution of neutral acetic acid and oxide of copper, are then carefully washed, darkly stained in aqueous solution of hæmatoxylin, decolorized to a bright yellow in very dilute hydrochloric acid solution (1:300–500). The acid is again neutralized, best in the copper solution; the sections become light bluish-green and are finally dehydrated and mounted. The staining thus laboriously effected is very well defined and graduated, and is also persistent. The portions of testis

* Arch. f. Mikr. Anat., xxvii. (1886) pp. 651–5 (1 pl.).

† Ibid., xxviii. (1886) pp. 305–95 (3 pls.). ‡ Ibid., xxx. (1887) pp. 49–110 (3 pls.).

examined were removed from the living or just-killed animal, and were placed in the preserving fluid in very small pieces.

Preparing Cochlea of Guinea-pig.*—Dr. G. Schwalbe places the fresh cochlea of the guinea-pig for eight to ten hours in Flemming's solution, and after thorough washing, decalcifies in one per cent. hydrochloric acid wherein it requires to remain for twenty-four hours. After the acid is quite washed out, absolute alcohol, xylol, xylol paraffin, saturation with Spee's paraffin at 35°–60° C. If the animal killed with the chloroform is allowed to hang with the head downwards for some hours, a perfectly natural injection of the cochlear vessels is obtained. To isolate these vessels, the following maceration method is recommended:—The cochlea filled with blood is decalcified in three per cent. hydrochloric acid and is then kept at a temperature of 40° in an incubator in the same acid. In one or two days the sheath of the cochlea is so softened that the nervous cochlea and its spiral expansion can be isolated from the basilar membrane, and the ductus cochlearis unwound from the expansion of the nerve. After separating the nerve and the duct the spiral vein can be seen with a low power lying by the ganglion spirale and beneath this the tractus spiralis glomerulorum winding round the nervus cochleæ.

Preparing the Central Nervous System of Acephala.†—For the examination of the central nervous system of mussels, Dr. B. Rawitz recommends (1) absolute alcohol 1 part to 3 parts distilled water. This keeps the parts perfectly and causes a slight isolation of the cells, and yet affords useful pictures after four to five weeks. With Solbrig's one-sixth spirit, the contents of the nerve-fibrils disappeared, and Ranvier's one-third spirit could only be used for one day as decomposition appearances occurred afterwards. (2) Bichromate of potash in solutions of 0·2, 0·05, 0·025 per cent. effected perfect maceration in 8 to 24 hours; after a longer period the tissues became completely softened. For hardening the animal in the shell a 5 per cent. solution was used for 4 to 6 weeks. The animals were then easily separated from the shell. After 8 days in absolute alcohol the ganglia were sectioned. (3) Bichromate of ammonia in 0·1 per cent. solution caused shrinking of the nuclei, and changes in the central nervous system. (4) Chromic acid is said to be as useless as a maceration medium as it is for hardening; even Arnold's chromacetic acid solution produced changes in the tissues. (5) Haller's fluid quite destroyed the nervous elements of the Acephala in half an hour. (6) Osmic acid was of very little use. Solutions of 0·1 and 0·05 per cent. were inferior to spirit or bichromate of potash; with solutions of 1 and 2 per cent. the cells seemed to be scorched. 5 to 10 drops of a cold saturated solution of picric acid to 15 cc. of distilled water effected the isolation of cells in 12 to 24 hours and gave good pictures. The mixture of spirit and iodine used by Fritsch for the brains of fish and followed by bichromate were found to make the nervous system very brittle.

As stains, rubin, safranin and eosin gave the best pictures. Gentian-violet, malachite-green, and Weigert's hæmatoxylin were useless. Ammoniacal carmine and much diluted solutions of "Rosenliqueurs" stain excellently, especially the central nervous network. The objects remain therein 4–10 days; they are then washed in spirit slightly acidulated with acetic acid, then absolute alcohol. Gold chloride in 0·1 to 0·25 per cent. solutions gives good pictures.

* 'Beiträge zur Physiologie. Carl Ludwig zu seinem 70. Geburtstage gewidmet von seinem Schülern,' 1887. Cf. *Zeitschr. f. Wiss. Mikr.*, iv. (1887) p. 90.

† *Jenaische Zeitschr. f. Naturwiss.*, xx. (1887) pp. 384–460 (5 pls.). Cf. *supra*, p. 735.

Preparation of Ova of Ants and Wasps.*—Dr. F. Blochmann examined *Camponotus ligniperda* Latr. and *Formica fusca* L. The ovaries were usually fixed with picric acid or sublimate, and stained on the slide with picrocarmine or borax-carminc. For examining the elements of the yolk, double staining with borax- or picrocarmine and bleu de Lyon are advised. The preparations, not always successful, show in favourable cases a blue staining of the yolk-granules and a rosy colour of the surrounding plasma, sometimes with a tendency to violet. A somewhat similar effect was obtained by the addition of a little picric acid to the turpentine oil used for clarifying. The yolk-sac and the chorion are recognizable from the deep blue they acquire from the bleu de Lyon. Young ova of *Camponotus ligniperda* are noteworthy on account of the rod-like corpuscles containing highly refracting granules, and which after being treated with 1 per cent. acetic acid appear more clearly. The addition of 5 per cent. soda solution to the rodlets causes them to pale in fifteen to thirty minutes, and finally to disappear, while the chromatin masses in the nuclei immediately disappear. Against the bacterial nature of these rodlets is to be said that bacteria from hay-infusion are not altered by immersion for three days in 5 per cent. soda solution. In dilute albumen solution in a moist chamber at 30°, after about twenty-four hours they inflate in places, and finally become quite bladder-like. In trypsin solution they become granular at first, and afterwards are partially dissolved.

Preparing Ova of Mysis Chamæleo.†—Herr J. Nusbaum is of opinion that one method of preservation can never afford satisfactory material for study, as each method gives different results. Thus, in treating fresh ova with Kleinenberg's or Perenyi's fluid we get large and distinct cellular elements, but the yolk is lost very easily; on the other hand, when the ova are treated for a few seconds with hot water and then with bichromate of potash, the yolk remains with the elements, but the latter contract. After the ova had been from twenty-four to forty-eight hours in a weak solution (1 per cent. of chromic acid or bichromate of potash, or for four to five hours in Kleinenberg's or Perenyi's fluid, they were put into 70 per cent. and then into absolute alcohol. The eggs thus hardened were coloured *in toto* by hæmatoxylin, borax-carminc, or red magdala; the first of these was very useful, because, in the early stages of development it gave a different coloration to the not yet modified yolk, and the yolk which was already modified by the influence of immigrated cells. As in all researches on Arthropods, the red magdala gave a perfect staining reagent, as it coloured the eggs and embryos in a relatively short time (a few hours), and very intensely, though sometimes too uniformly.

The hardened and stained egg was put into alcohol, then into a mixture of equal parts of 70 per cent. alcohol and essence of cloves, and then into pure essence of cloves, until it became transparent; it was then plunged for a short time into essence of turpentine, and finally imbedded in paraffin. Sections were made by Schanze's microtome, fixed by collodion and essence of cloves, and put up in Canada balsam.

Preparation of Male Reproductive Organs of Cypridæ.‡—Dr. F. Stahlman teases out the fresh animal in physiological salt solution, and stains with picrocarmine, methyl-green, acetic acid, Schneider's acetic carminc. The best fixation is with hot water from 60–65°, or with hot

* Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 537–720 (5 pls. and 6 figs.).

† Arch. Zool. Expér. et Gén., v. (1887) pp. 124–5.

‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 511–2. From Zool. Inst. zu Freiburg i. B., 1886, 33 pp. (1 pl.).

30 per cent. spirit. The latter makes the tissue somewhat too brittle. The best staining results were obtained from Ranvier's picocarmine, but borax-carmine, lithium-carmine, hæmatoxylin, and eosin were also used. The lime in the shell is extracted by acting on it for twenty-four to forty-eight hours with a concentrated solution of picric acid in an incubator, and the acid removed by immersion for a similar period in water heated as before. Perforation or slight fracture of the shell hastens the staining, &c. Flemming's solution is not very advantageous, because it penetrates too slowly. Lively movements of the spermatozoa of *Cypris punctata* Jur. and *Cypris monacha* Müll. may often be perceived after teasing open a receptaculum seminis in three-fourths salt solution. The spermatic filament of an undetermined Cyprid was uniformly stained with methyl-green, and scarcely altered at all by long immersion in concentrated hydrochloric acid or caustic potash.

Preparation of endothelium of the general cavity of Arenicola and Lumbrica.*—M. H. Viallanes anæsthetizes the animal by immersing it for an hour in sea water to which chloroform is added. It is then spread out on a wooden plate and fixed with two pins. The middle zone is opened by a longitudinal incision and the integument reflected and fixed down with pins. A piece of the alimentary canal and of the muscular sheath from the anterior and posterior ends of the body are removed and then washed with water and with an acid 0.01 per cent. solution of silver oxide. It is again washed, and then placed in 36 per cent. spirit until the silver is reduced. Immersion in spirit is necessary, because if reduction take place in water the muscles contract and further observation is rendered difficult. When the silver oxide is sufficiently reduced the piece is removed, cleared up in clove oil, and mounted in balsam. This procedure brings out the endothelial cells covering the muscles with perfect clearness.

In order to show the endothelium covering the interannular septa the following method is useful. The annelid is first syringed with one-third spirit and then immersed for twenty-four hours in 80 per cent. spirit. The animal is then opened, one of the septa (the third is the most perfect and best for observation) isolated, carefully spread on a slide, and examined after being stained with picocarmine or eosin and logwood. By the action of 30 per cent. spirit the endothelial cells are set free, and only the tissue forming the framework of the septum remains.

Preparing Eggs of Rotatoria.†—Dr. G. Tessin states that it is very difficult to obtain good preparations from the small eggs of Rotatoria. With those of *Brachionus* he usually proceeds by rapidly killing the egg in chrom-acetic acid; no distortion results. From weak they are transferred to strong spirit. Picrosulphuric acid produces great distortion, and sublimate does not penetrate. Staining is only possible with hæmatoxylin, as carmine is useless. Creosote is the best clarifier. Paraffin only penetrates with difficulty.

Examination of Nectarial Tissue.‡—Dr. S. Stadler finds that osmic acid is a test for tannin, which it stains brown to a black or blue violet. If any fatty oils are present the test cannot be employed. The author, who had previously used three kinds of zinc chlor-iodide solution for the examination of the cell-wall and of the cuticle in nectaries, has, on account

* Ann. Sci. Nat.—Zool., xx. (1886) 10 pp., 1 pl.

† Zeitschr. f. Wiss. Zool., xlv. (1886) pp. 273-302 (2 pls.). See this Journal, ante, p. 94.

‡ Stadler, S., 'Beitr. z. Kenntniss der Nectarien u. Biologie der Blüten,' 88 pp., 8 pls., Svo, Berlin, 1886.

of the trouble and time expended in making these solutions, now adopted the following method.

The preparation is placed on a slide with a drop of zinc chloride solution; to this is added a drop of a weak iodine solution, and the cover-glass is then imposed. The reaction immediately takes place, and if the chloride is in excess, the iodine colour disappears from everywhere except the stained parts of the preparation. It seems indifferent which reagent is first used.

Mounting Mosses.*—Miss V. A. Latham gives the following directions for mounting mosses:—

"We will take the pretty moss, *Dicranum heteromallus*. The chief beauty in this moss lies in the capsule, and I may remark here that mosses for mounting should be in fruit, and, what is more, ripe. The peristome is very pretty, and we must try and preserve the capsule uninjured. In its natural state, when growing and quite ripe, the calyptra and operculum are thrown off, the peristome unfolds itself, and the spores issue from the capsule, and either fall to the ground or are scattered by the wind. All this should be borne in mind whilst mounting mosses, and if you can show the spores leaving the capsule, and also the calyptra and operculum, so much the better. Gently shake, and remove, with the aid of a small sable brush, as much dirt, dust, and grit as you can. Then place the specimens in clean water, and shortly the leaves will expand and look as fresh and green as when growing. Use your brush, and move them carefully and quickly about in the water to further cleanse them. Transfer to a small bottle of water again, and shake carefully. Change the water, and repeat if necessary. During washing the opercula will probably fall from the capsules; therefore keep a look out. Take from bottle, examine your specimens, and remove ragged and imperfect portions, if any; place upon slip, and see if clean with a low power. If so, you will be lucky. Most probably you will find it necessary to use the brush again, holding the moss under water with one brush whilst you clean with another. You can try placing them in a saucer, and letting the water tap drop on them. Now arrange your moss on a slip, unfold and spread out the leaves gracefully and naturally, and with the capsules placed with an eye to artistic effect, as if growing. Put three small beads or portions of broken glass circles for the edges of your cover-glass to rest evenly upon, so as not to rest upon and burst the capsules, and to prevent tilting. Put on the cover-glass and secure with wire clip; drop the glycerin jelly round the edge of the cover, and it will run under. Now gently heat until ebullition takes place. This operation requires a little practice, but when done successfully, it drives out all air-bubbles, liberates a few spores from the capsule, and makes the leaves more transparent for examination. Should the spores leave the capsule in excess and cloud the field, transfer to clean slip and repeat the process. Good glycerin jelly will set immediately, when you may possibly find the boiling has interfered a little with the nice (that is, natural) position of some of the leaves and capsules. If so, warm the slide until the jelly is in a fluid state, insert the needle under the cover, and replace all straight; at the same time, and by the same means, push under and place in position the opercula.

Occasionally there may be a desire to preserve intact the beautiful fresh green tint of the leaves. In that case, after you have got your moss clean, soak it in glycerin for several weeks until the glycerin has thoroughly permeated and driven out all air from the capsules and leaves. When ready, place a warm slip on your mounting stage, put your moss in

* *Scientif. Enquirer*, ii. (1887) pp. 156-7.

the centre, and with the aid of a lens arrange as straight a line as possible, seeing at the same time any air-bubbles are dislodged either with a needle-point or gentle pressure of some kind. Apply the jelly, dip your cover in warm water, put over all, and gently press down. In adopting this method, you are not very sure of keeping the moss as artistically displayed as you could wish, but the judicious use of a needle, quickly handled before the jelly sets, will put right any serious defect. Ring and finish as with other slides. This is Captain P. G. Cunliffe's method, and was used by him in preparing his slides for the Manchester Cryptogamic Society, and which were acknowledged by all to be beautifully mounted specimens."

Cleaning and arranging Diatoms.*—Dr. F. S. Newcomer proceeds as follows:—He uses a test-tube 10 in. long and 1/4 in. in diameter, cuts the *Zostera marina* into inch lengths for convenience of boiling, boils to wash out the chloride of sodium, then boils in bicarbonate of soda to break up the fibres of the plant, then washes out the soda, and having poured into a Berlin dish, evaporates the remaining water. Sulphuric acid is then added until the organic matter is completely charred. The mass is then deflagrated with chlorate or nitrate of potash. After the acid is cooled, about a quart of distilled water is poured in gradually, and stirred the while. The acid having been removed, any flocculent material is got rid of by boiling with soap (not more than 10 grs. to the test-tube). When the soap is washed away, the diatoms will be clean and bright. The diatoms are extracted by pouring the material into a Berlin dish; the diatoms will be found at the top and the sand, if any, at the bottom of the dish. It is not advisable to throw away the sand, as the largest diatoms are frequently found among it. The material is preserved in a mixture of equal parts of spirit and water.

Diatomaceous earths require great patience; the Barbados material, in which there are traces of iron, is best treated at first with a concentrated solution of citric acid.

In arranging geometric forms of diatoms a guide slide with micrometer circles is used. On this is placed the cover-glass by moistening the surface of the guide slide by breathing upon it; then centered with a pocket lens. The best fixative for the purpose is that of Mr. Febiger: glacial acetic acid 12 fluid drachms, gelatin 2 drachms, alcohol 1 fluid drachm. The gelatin is dissolved by adding the acid over a water-bath, and after the alcohol is mixed in the whole is filtered. The fixative is then spread across the face of the cover-glass by means of the finest cambric needle. The slide on which the diatoms are to be arranged is then fixed on a turntable, and a ring the size of the cover-glass run on with any anilin ink or colour; the slide is then turned over, heated, and a drop of balsam placed upon it and the cover-glass on it, the anilin ring on the under side being used as a guide. The slide is finished off by running the flame of a spirit-lamp round the edge of the cover-glass. The flame of the lamp must be turned down until it is blue.

Cleaning Diatomaceous Mud.†—Dr. G. H. Taylor does not agree with Mr. C. H. Kain as to the avoidance of muds in the collection of diatoms. If muds are avoided, some of the finest specimens obtainable are missed. The author is now engaged in working up the muds of the North Carolina coast. This mud is most difficult to clean, that is, to eliminate the sand; as much as 250 gallons of water have been used before obtaining enough material in a cleaned state to cover the bottom of a half-drachm phial.

* Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 128-30.

† Bull. Torrey Bot. Club, xiv. (1887) pp. 141-3.

The great mistake generally made in cleaning marine muds is that not enough care is taken in the first washings with water. The author's method is to remove all sand possible before shaking is commenced, for the violent agitation of a mixture of sand and diatoms is prejudicial to the latter. Only as much raw material should be placed in the bottle or jar as will settle in ten minutes, and this should be repeatedly washed until the water will settle clear in a few minutes. The jar should not be shaken, but rotated, and the sand removed after each settling.

Preservation of recent Pathological Specimens.*—Prof. E. Lund preserves recent pathological specimens by placing them in an air-tight vessel filled with the vapour of sulphuric ether, chloroform, or ether and creosote previously mixed with alcohol. Several thick folds of lint, saturated with one of these solutions, are put at the bottom of the vessel, and the specimens are arranged in trays over it, so that the vapour can have free access to each of the specimens. In this way the specimens are always ready for examination, without being softened or decolorized by immersion in weak spirit and water or other preservative fluids. The cover of the vessel can be made air-tight by a vulcanized indiarubber ring, on which the edge of the lid is firmly pressed, or by allowing it to dip into a groove around the top of the vessel, which can be filled with vaseline, or, better still, with liquid mercury, if the vessel is not to be much moved about from place to place.

COURROUX, E. S.—On the washing and cleansing of diatomaceous deposits.

Scientif. Enquirer, II. (1887) pp. 144-7.

QUIMBY, B. F.—Insect Preparations. I.

[Collecting. Fluids. Implements (including a mounting and dissecting box, illuminated by a mirror set at 45°). Preparation.]

Microscope, VII. (1887) pp. 197-202.

STOSS.—Notizen über Anfertigung mikroskopischer Parasitenpräparate. (Notes on making microscopical preparations of parasites.)

Deutsche Zeitschr. f. Thiermed., XIII. (1887) pp. 202-5.

(3) Cutting, including Imbedding and Microtomes.

Celloidin-Paraffin Imbedding.†—In order to obviate the difficulties and inconveniences inherent in the methods of imbedding in celloidin and paraffin, Dr. Kultschizky has devised a combination of these two media which are manipulated as follows:—The object, taken from spirit, is placed for some hours in a mixture of equal parts of ether and alcohol. It is then removed to a solution of celloidin of any strength; herein it remains for twenty-four hours. From the celloidin the object is transferred to origanum oil, and then to a mixture of paraffin and origanum oil which has been heated to 40°, and finally to melted paraffin. The time which the object remains in the origanum oil, the paraffin solution, and in the melted paraffin, must be determined by trial, as it depends on the characteristics of the imbedded objects.

The chief advantages claimed for this method are that very fragile objects can be imbedded; that very thin sections, owing to the celloidin, do not break up, even though the paraffin has given way; that it is not necessary to use an alcoholic drip while cutting; and that sections of the same tenuity as those from paraffin in imbedding can be obtained.

Water-bath for Paraffin Imbedding.‡—Dr. P. Mayer has in conjunction with Dr. W. Giesbrecht and Dr. G. C. J. Vosmaer, devised a convenient

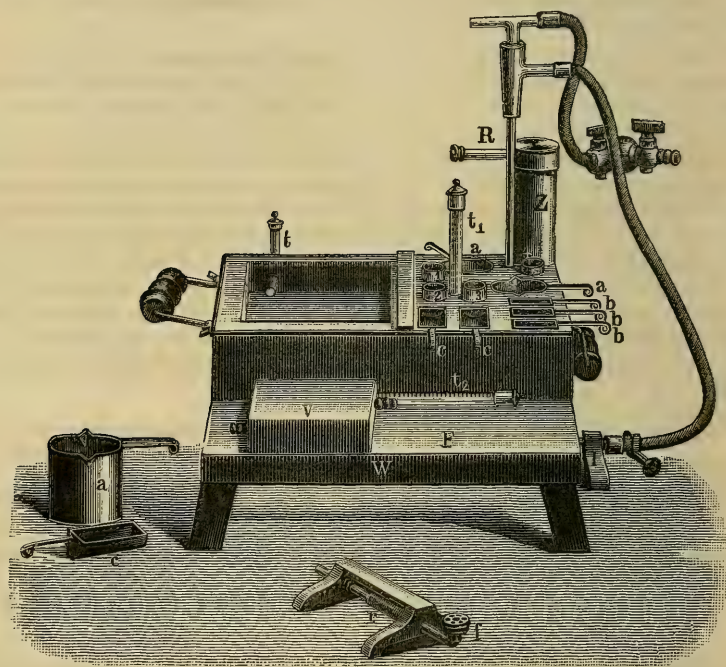
* *Scientif. Enquirer*, ii. (1887) p. 148.

† *Zeitschr. f. Wiss. Mikr.*, iv. (1887) pp. 48-9.

‡ *Internat. Monatschr. f. Anat. u. Physiol.*, iv. (1887) Heft 2, 1 fig.

form of water-bath for paraffin imbedding. W is the bath; Z the tube by which it is filled with water; 1, 2, 3, 4, are glass tubes; *a* is a pot for melting and clarifying the paraffin; *b* and *c* are half-cylinders with handles for imbedding; *t* is a thermometer bent at a right angle; the horizontal leg ends in the air-bath, which can be closed with a glass plate. The

FIG. 229.



temperature in the air-bath is about 10° less than the water-bath, and it is used for evaporating chloroform, &c.; t_1 is the thermometer for the water-bath; R is a Reichert's thermo-regulator. The variation in temperature is less than 1° C. *r* is the tube in which the gas and air mix, and *f* a mica chimney. There is a small independent and removable water-bath *v* fitted with water by means of rubber tubes attached to lateral openings. It is supplied with a thermometer t_2 , is warmed on the platform F, and is intended chiefly for orienting objects under a simple lens or dissecting Microscope.

Modification of Reichert's Object-holder.*—Dr. J. H. List has made two alterations in this object-holder, by which greater mobility of the ball-and-socket joint and greater space for the play of the knife are obtained. The jaws of the clamp holding the object are now made convex, and the ball-and-socket joint works in one of the jaws. No impediment is therefore offered to the knife, even when the clamp is turned to its utmost. By shortening one of the screws moving the jaws still more room is obtained.

Modification of the Naples Section-smoother.†—In order to increase the size of the Naples section-smoother, which is somewhat too thin,

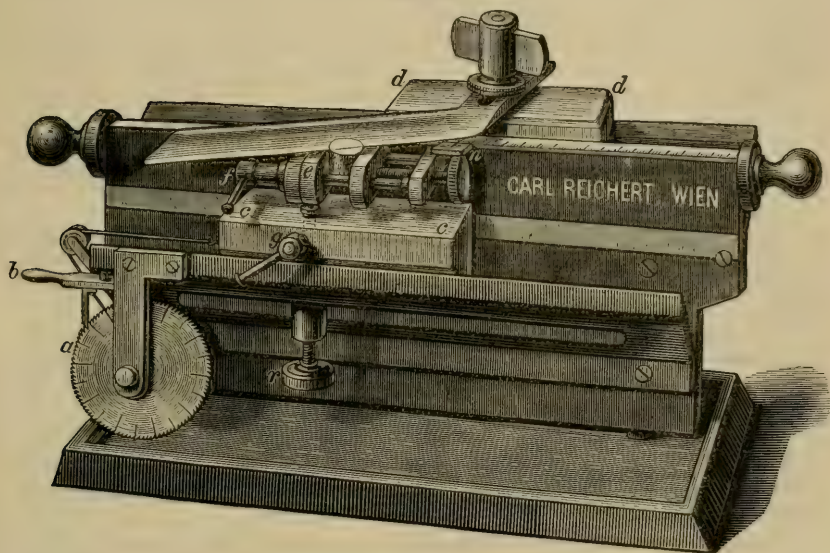
* Zeitschr. f. Wiss. Mikr., iii. (1886) p. 484.

† Internat. Monatschr. f. Anat. u. Physiol., iv. (1887) Heft 2.

Dr. P. Mayer advises that strips of gelatin plate, such as are used by lithographers, should be stuck on the cylinder with some very soft paraffin.

Reichert's small Rivet's Microtome.—The only peculiarity, so far as we are aware, of Herr C. Reichert's latest form of this Microtome (fig. 231)

FIG. 231.



consists in the arrangement for raising the object-holder, which is effected by a cord which winds round the axis of the toothed wheel *a*.

LETULLE.—Microtome de précision.

Bull. Soc. Anat. Paris, XI. (1886) p. 355.

(4) Staining and Injecting.

Carmin solution made with Carbonate of Soda.*—Dr. G. Cuccati's improved carmine stain, especially suited for animal tissues, is made as follows:—Warm water 100 cc.; carbonate of soda crystals 20 grms.; mix and heat; add best powdered carmine 5 grms.; stir and cover. When it boils cease heating, and add absolute alcohol 30 cc. Allow to cool in a partially closed vessel. Next day filter, and add to the filtrate 300 cc. H_2O , acidulated with 8 cc. of a 20 per cent. solution of acetic acid. Next add chloral hydrate 2 grms. Decolorize with 100 cc. spirit and hydrochloric acid 1 cc. This carmine acts intensely on the chromatin of the nucleus, showing up the karyokinetic figures quite brilliantly. It stains *in toto* very well tissues treated with spirit, perchloride of mercury, or Kleinenberg's fluid, in five to twelve hours, according to the size of the piece. Staining of sections or pieces *in toto* must always be performed in closed vessels, and before decoloration these must be washed for a few seconds in distilled water. This carmine also has the power of removing the pigment from the eyes of arthropods which have been treated with spirit, while it stains the nuclei of the retinal cells at the same time.

* *Zeitschr. f. Wiss. Mikr.*, iv. (1887) pp. 50-1.

Mayer's Modification of Grenacher's Carmine.*—Dr. P. Mayer thus modifies Grenacher's carmine:—4 gr. carmine are dissolved by boiling in 15 cc. water and 30 drops of hydrochloric acid; 95 cc. of 85 per cent. alcohol are then added, and the mixture then neutralized with ammonia.

Acid Chloral hydrate Carmine.†—Dr. Kultschizky recommends a carmine stain which is prepared by mixing chloral hydrate 10 grms., hydrochloric acid, 2 per cent., 100 cc., and 1 gm. dry carmine. The mixture is boiled from an hour to an hour and a half in a flask. Too much evaporation is prevented by corking the flask, and passing a glass tube through the cork. The solution is allowed to cool for twenty-four hours, and is then filtered.

Thus prepared, the solution gives a red stain, but if a violet be preferred, the sections are to be immersed in a 2 per cent. alum solution afterwards. The omission of the acid gives a neutral solution, which may be used in conjunction with Grenacher's alum-carmine and also picric acid, and a double stain thereby obtained.

New method for making Picrocarmine.‡—Dr. N. Löwenthal supersedes ammonia with the hydroxide of sodium in preparing picrocarmine. Picrocarminate of soda is a very powerful stain, especially for the central nervous system.

(1) The carmine solution is composed of water 100 cc.; sodium hydroxide 1 g.; carmine 0.4 g. The sodium is dissolved in the water, and the carmine added. The solution is effected in the cold in 24 hours, and in 10–15 minutes with the aid of heat. The solution is then filtered.

(2) To solution No. 1, 100 cc. of water is added, and then 20–25 cc. of a 1 per cent. solution of picric acid poured in. The solution, which is rather cloudy, is allowed to stand for about an hour, and is then filtered twice or thrice.

Employment of Perruthenic Acid in Histological Researches.§—Prof. L. Ranvier has a note on the employment in histological researches of perruthenic acid, and its application to the study of the vacuoles of calyciform cells. He has learnt, from a demonstration of M. Debray, that this acid (RuO^4) is reduced in the presence of organic bodies much more actively than in osmic acid. This reducing action is so rapid and so easy that the retrolingual membrane of the frog, although it contains a number of very different elements, becomes completely black when subjected to the influence of the vapour for a few minutes. If we gradually diminish the time of action, it will be found that the membrane is darkened for a diminishing thickness, but all the elements comprised in one layer are equally blackened. If the time of exposure has been very short, the cilia of the epithelial cells may alone be blackened.

This "brutality" of perruthenic acid seems, at first sight, to deprive it of all value as a histological reagent, but Prof. Ranvier reflected on the mode of action of osmic acid, and coming to the conclusion that the result of exposure to osmic acid is a sort of metallization of the organic elements, he judged that those which were the least blackened were the least metallized. If this were so, the mucigen which remains uncoloured in the retrolingual membrane treated with osmic acid would offer the largest amount of disposable organic substance. After the retrolingual membrane has been exposed to the vapour of osmic acid from ten to twelve hours the calyciform cells appear as clear colourless circles. If now submitted to the action of

* Internat. Monatschr. f. Anat. u. Physiol., iv. (1887) Heft 2.

† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 46–8.

‡ Anat. Anzeig., ii. (1887) pp. 22–4.

§ Comptes Rendus, cv. (1887) pp. 145–9.

the vapour of perruthenic acid the membrane blackens, and the calyciform cells are the first to become black, the mucigen alone being coloured, and the vacuoles remaining colourless.

Methylen-blue Staining.*—Dr. C. Arnstein has examined methylen-blue staining on the living frog by injecting into the vena cutanea magna 1 cc. of a saturated solution of this dye. The tongue and palate were stained at once, the nerves were not coloured, the dye being found in the blood-vessels only. One or two hours later the nervelets in the taste papillæ and the thick plexuses of the palate are seen to be blue. The motor-nerve terminations become stained still later. Reichert's pleural muscle may be used to determine the appearance of the stain. "One muscle is removed in two hours, and if insufficiently stained, the second muscle is inspected after another two hours. The eye-muscles are treated in a similar manner, one ball being removed at an early stage, the other at the end of the experiment." Sometimes, however, these muscles do not stain at all, and even if the nerves are well stained they remain so only for a short time, 5-10 minutes about. To retain the colour it is necessary to fix the methylen-blue with iodine, and this reaction turns the blue to brown. A 1 per cent. watery solution of iodide of potassium in iodine dissolved to saturation, is used. The solution is injected through the blood circulation system, and serves also to remove the blood. The frog may be allowed to remain in this solution. The necessary pieces are then cut out and placed in the iodine solution for 6-12 hours, after which the iodine is removed by a thorough washing. Next day the black-brown or grey nerves stand out clearly on a colourless background. Mount in acidulated glycerin. Besides nerves and nerve epithelia, certain other elements are stained during life, such as the cells in the gustatory papillæ of the frog's tongue, certain cells of the palate which lie between the unstained mucous cells, the gland-cells of the membrana nictitans, the cells of the propria in the lingual glands, which as isolation preparations treated with iodine, appears as brown ramified plates. The cells of the cornea, too, are partially stained if the ball be allowed to remain *in situ* for a short time after death. The cornea is then excised and thrown into the iodine solution, but the staining of the corneal cells only occurs when the plexus has been stained during life. Over gold chloride it has the advantage of staining only the cells and their prolongations, and not the lymph channels of the connective tissue cells; those which show the most affinity for methylen-blue are the fat-cells. At one time they stain deeply, even when the nerves are yet uncoloured; later they seem to lose their colour. Sometimes after death they are again very beautifully stained. During life, many red blood-corpuscles show a nuclear stain, but the white corpuscles do not take up any dye.

New Green Dye.†—Dr. W. Krause has been examining a double zinc salt of thiophin-green ($C_{21}H_{24}N_2OS$) as to its utility for microscopical purposes. It is easily soluble in water, alcohol, oil of cloves, chloroform, with a beautiful green colour in which there is a trace of blue. It may be used in conjunction with carmine as a double stain. Fresh tissue hardened in absolute alcohol. Staining with borax-carmine *in toto*, washing, spirit, chloroform-paraffin, paraffin. Sections 0.005 mm. thick fixed to the slide. Collodion, clove oil, paraffin dissolved in benzol, and then removed with absolute alcohol. A drop of a concentrated watery solution of thiophin-green is allowed to act on the moist section for some minutes. It is then

* Anat. Anzeig., ii. (1887) pp. 125-35.

† Internat. Monatschr. f. Anat. u. Physiol., iv. (1887) 2 pp.

washed with absolute alcohol. Benzol. Benzol dammar. (If not washed thoroughly the nuclei are blackish instead of red; if too long, the ground substance is too pale.) The stain was used for the electric organ and embryos of the torpedo. The nuclei of fish-corpuscles are red, the plasma green.

New Formula for Burrill's Stain.*—Prof. T. J. Burrill finds the following formula gives excellent results in staining *Bacillus tuberculosis*:—Fuchsin (anilin-red), 1 part; pure carbolic acid 2·5 parts; glycerin (commercial) 10 parts.

The directions for use are as follows:—Add 3 drops of this stain to a drachm (teaspoonful) of distilled or soft water; float a cover-glass, on which a thin film of sputum hardened by heat has been spread, on the liquid and heat to near boiling; remove from lamp and let stand two or three minutes; decolorize in nitric acid (1 part) and water (5 parts); wash in water, and examine, or dry and mount in balsam. Contrast stain, if desired, after the first decolorizing, with anilin-blue.

This formula is much more satisfactory than the previous one, for there is less liability of precipitation of granules on the cover, and the time is greatly shortened.

In the absence of other apparatus, &c., a cheap tablespoon, with the end of the handle bent down to make a level support, answers excellently well for holding and heating the stand, and nothing can be better for the heating than a common coal-oil lamp, the watch-glass, crucible-cover, spoon, or what not being held above the top of the chimney. This is better, too, for hardening the sputum-film than the flame of a Bunsen burner.

Prof. Burrill is sure this stain will keep, for there is nothing in it to precipitate by keeping, as so generally occurs with anilin-oil mixtures.

Staining Elastic Fibres.†—Dr. G. Martinotti fixes and hardens the material with a 0·2 per cent. solution of chromic acid. The sections, after having been well washed in water, are placed for forty-eight hours in a solution of safranin (safranin 5 parts, dissolved in absolute alcohol 100 parts, to which 200 parts of water are added after a few days). The sections are again washed, dehydrated in spirit, cleared up in oil of cloves, and mounted in balsam. The elastic fibres are stained a deep black, the nuclei are of a bright red colour, and the rest of the specimen is stained diffusely red. The elastic fibres come out quite clear and distinct; those in arterial walls are especially suited for this method.

Nerve Staining.‡—Dr. J. Pal remarks that Golgi's method causes a precipitate of mercury upon the cells, for if the sublimate pieces are treated with a 1/2–1 per cent. solution of soda sulphide, the staining is more intense, owing to the formation of sulphide of mercury. Such preparations, after being stained with a bright red, give excellent pictures. The author, however, succeeded in staining all the cells by Golgi's method. By the silver method such good pictures are not obtained, and there is more precipitate than occurs from the use of sublimate. As the chromic acid silver salt is soluble in many dyes, it is necessary, if a contrast stain be desired, to change the salt into mercury sulphide by means of soda sulphide.

Golgi's cell-staining may be used in conjunction with Weigert's hæmatoxylin stain. The sections which have lost, either in the sublimate or silver solutions or in water, their chromic salt, must be placed in a 1/2 per cent. solution of chromic acid for twenty-four hours. Then, without the copper

* Queen's Micr. Bulletin, iv. (1887) p. 24.

† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 31–4.

‡ Wien. Med. Jahrb., 1886. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 92–6.

treatment, Weigert's logwood may be used in the ordinary manner. For decolorizing these sections, or those prepared by the original method of Weigert, the author proposes a new reagent, with the intent of quite removing the stain from the interstitial tissue, in order that this may be contrast-stained. The blue-black sections are placed in water, to which some alkali (1-2 cc. of lithia solution to 100 cc. water) is added if the preparation does not seem stained a deep blue. From the water the sections are transferred to 1/4 per cent. solution of permanganate of potash for 20-30 seconds. They are next washed with water, and then transferred to the following acid fluid:—Oxalic acid, 1 part; sulphite of potash (K_2SO_3) 1 part; aq. destil. 200 parts. In a few seconds the sections are sufficiently decolorized. They are then stained with Magdala red or eosin (4-5 minutes), or still better, with picrocarmine or with acetic acid carmine. Should any spots remain after the acid solution, the section must be returned to the permanganate solution for a moment, and the process repeated. Should the sections have been treated with copper, the medullary sheath becomes red-brown in the acid solution, and accordingly requires an alkaline bath, or some suitable afterstain, as malachite green. It is advisable that the permanganate solution should be made fresh every time, and should be changed as soon as it shows a trace of brown. So too the acid solution should be promptly replaced by a fresh quantity directly it begins to act slowly. The foregoing method of decolorizing has the disadvantage that each section or preparation requires the greatest attention on the part of the operator.

Exner had treated osmic acid preparations of the central nervous system with ammonia, and thereby brought out many very fine nerve-fibres. Instead of ammonia, Pal used the reagents in the foregoing logwood method. But for the cortex he advises weak ammonia (0.1 cc. ammonia to 100 cc. water). The procedure is as follows:—Very small pieces of brain are hardened in 1 per cent. osmic acid for four to six days, the fluid being changed daily. The piece is then washed with distilled water, laid in absolute alcohol for one or two minutes, imbedded in celloidin and then in wax or paraffin, and then sectioned. The sections are removed from the knife to pure glycerin, or diluted with 1/4 water. Therein they may be allowed to remain for a length of time, but when required for use the glycerin must be thoroughly removed. The sections are then removed with 1/4 per cent. of permanganate solution for ten to fifteen seconds, after which they are transferred to the acid solution. The sections having been carefully washed, are then stained again with some red dye (Magdala red, neutral picrocarmine, acetic acid carmine). Mounting may be done in glycerin, or after dehydration and clearing up, in xylol or creosote in dammar.

Staining Tubercle Bacilli.*—The contribution of Dr. P. Ehrlich on staining tubercle bacilli is chiefly occupied by problematical doctrines about the capacity of the bacterial envelope for taking up dyes. These doctrines simply amount to the well-known facts that alkalis, anilin, and phenol render the envelope more penetrable to stains, that mineral acids penetrate relatively slowly, and that the membrane, when under the influence of acids, is quite impenetrable to the compound molecules of the ordinary dyes.

The author's hints on practice are more valuable than his theories. Thus he remarks that contrast stains, such as Bismarck brown for methylviolet, and methylen-blue for fuchsin, should be slightly acidulated with acetic acid.

* Charité-Annalen, 1886. Cf. Zeitsch. f. Wiss. Mikr., iii. (1886) pp. 525-30.

For cover preparations the glasses used by him are from 0·01–0·012 in. thick. The sputum is pressed into a thin and even layer, and before separating the two covers they are laid on a hot plate at a temperature of nearly 100° C. until coagulation, shown by opacity, occurs.

For staining, the author usually employs anilin-fuchsin, and for decoloration nitric acid diluted with 2 parts of saturated sulphanilic acid. Decoloration is not continuous, but is performed at intervals of a few seconds, and each time the acid is thoroughly washed away.

For demonstrating tubercle bacilli in fragments of tissue where thin sections are only obtainable with difficulty, the author adopts the following method:—

(1) Stain cover preparations in watery solution of fuchsin for twenty-four hours. (2) Anilin-fuchsin for twenty-four hours. (3) Wash in spirit, or for a short while in sulphanilin nitric acid, afterwards washing with water carefully. (4) Immerse in concentrated solution of sodium sulphide for twenty-four hours, and then transfer to a vessel filled with recently boiled water. (5) Dry the preparation and examine, without contrast staining, in balsam.

Chemistry of Staining.*—Herr P. G. Unna has made a further contribution to the chemical theory of staining. He has previously shown that two reagents, metaphenylenediamine and nitric acid, which outside the tissue at once unite into the brown triamidoazobenzol (vesuvin), when separately introduced into the tissue lose this affinity. He has utilized sections of leprous skin hardened in alcohol for the corroboration of his theory of the occurrence of a chemical process in staining. This tissue was peculiarly suitable as containing within a minimum space the most diverse vegetable and animal substances.

By mixing equal parts of an aqueous solution of metatoluylenediamine and hydrochloric acid with nitrosodimethyl anilin, there results the beautiful deep-blue solution of toluylene-blue. When sections of the above skin are treated with 1 per cent. of this blue in aqueous-alcoholic solution they stain blue. The vegetable parasites become dark-blue, and by solution in certain acids the general blue colour of the rest of the section is replaced by red in certain regions. But if the two components be introduced separately into the tissue the result is quite different. The difference is carefully analysed, and a chemical explanation offered. It is impossible to summarize the chemical details by which the author seeks to corroborate his point. By union with the tissue a colouring substance may lose its reducibility or another its power of being oxidized. In some cases the section appears to act as an alkali. The paper is an interesting attempt to rationalize our highly elaborated technique.

FERRÉ, J.—Acide osmique et procédé d'Ehrlich dans la préparation du bacille de la lèpre. (Osmic acid and Ehrlich's process in the preparation of the bacillus of leprosy.) *Journ. de Med. Bordeaux*, 1887, p. 622.

GEDOELST, L.—Un nouveau procédé pour préparer le picro-carminé. (New process for preparing picro-carminé.) *Moniteur du Pract.*, III. (1887) p. 91.

GÜNTHER, C.—Ueber die mikroskopische Färbung der wichtigsten pathogenen Bakterien mit Anilinfarbstoffen. (On the microscopic staining of the most important pathogenic bacteria with anilin colouring matters.)

Deutsche Med. Wochenschr., 1887, pp. 471–5.

Imada, Y.—An improved Fluid for Injection.

[Transl. from the 'Chū-gwai lji-schimpō.]

Sei-i-Kwai Med. Journ. Tokio, VI. (1887) p. 7.

(5) Mounting, including Slides, Preservative Fluids, &c.

Treatment of Sections which have been imbedded in Paraffin.*—Dr. H. Strasser removes the paraffin with benzin or with warmed turpentine, after which the sections are placed in chloroform for a short time and then in 60 per cent. spirit. From the spirit they are transferred to solutions, either watery, or mixed with a little spirit.

When treating serial sections the author has somewhat modified his former method for producing paper plates covered with gum and collodion. Sheets of stout smooth writing paper are pinned down to any flat surface and brushed over with a solution of gum arabic. With the mucilage of gum arabic of the pharmacopœia is mixed $\frac{1}{5}$ vol. of glycerin. This addition renders pressing the sheets superfluous. When the gum layer is dry, it is coated over with collodion thinned down with ether to the consistency of glycerin, and $\frac{1}{100}$ vol. of castor oil added to impart elasticity. The collodion mixture should be smeared on with a large soft brush, and with practice several layers can be put on in a few minutes. Thus prepared they are folded in the middle, the paper side outwards, and laid aside till wanted. The sections are stuck on with the following mixture:—Collodion 2 vols, ether 2 vols, castor oil 3 vols. Care must be taken that no air remain under the section, and when it is fairly fixed, the surface is brushed over with the same solution. The plates thus prepared are then immersed in benzin or turpentine for a half to several hours. Turpentine is to be preferred for most reasons, while the chief advantage of benzin is that the plates require less careful manipulation. The plates are then placed in chloroform, from which in fifteen minutes or longer they are transferred to 80–85 per cent. spirit, wherein the collodion is gradually hardened.

Fixing Sections.†—Clouding of the shellac used for sticking on sections can be avoided by dissolving the shellac in carbolic acid. But as the acid attacks many tissues—for example, the skin of vertebrates—the author recommends the warm slide to be smeared with an alcoholic solution of shellac, and then allowed to cool. The sections are then placed on dry, and having been carefully smoothed out, are exposed to the vapour of ether. This is most easily and simply done by putting the slide in a vessel, at the bottom of which is some ether. The vessel is then closed, and in about half a minute the sections are saturated with ether, which is afterwards removed in a water-bath. The further treatment is as usual. Softening the shellac with ether vapour is not so safe for brittle sections as the carbolic shellac. As chloroform also softens shellac, the use of chloroform balsam is rather dangerous; it is safer to use turpentine or benzol (not benzin) balsam.

The formula given for the author's albumen adhesive is:—Albumen 50 cc.; glycerin 50 cc.; salicylate of soda 1 gr.; the mixture is to be well shaken, and then filtered into a clean bottle. Is said to keep for at least three years.

Eternod's Turntable "to serve several purposes."‡—Prof. A. Eternod has utilized the body of the turntable (fig. 232), so that it is now available for different purposes, and this is effected without increase of space, a desideratum to many workers. The turntable is at *a*, the upper surface

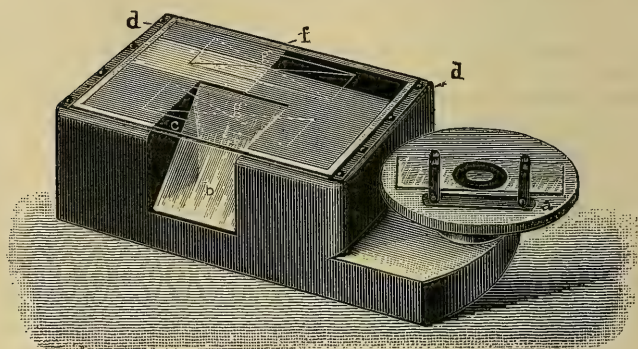
* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 44–6.

† Internat. Monatschr. f. Anat. u. Physiol., iv. (1887) Heft 2.

‡ Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 41–2 (1 fig.).

of the body of the stand is filled with a plate of glass *c*, the bevelled edges of which are fixed by a strip of metal *d*. Part of one side is excavated so that a mirror *b* can be fitted in. Beneath one half of the glass plate is a strip of cardboard *f*, stained in different colours, blue, green, red, black, or white; at *g g* are two devices drawn with a diamond for exactly centering

FIG. 232.



objects on the slide. The use of the mirror is for finding specimens immersed in dark staining fluids. Above the coloured paper, objects can be teased out on grounds suitable to their colour.

Wax as a Cell Material.*—Mr. J. E. Whitney recommends the sheet wax used for making artificial flowers as a material for cells. The objection usually raised against wax as a dry mount, is that it sweats, and consequently the mounted objects become obscured by condensed vapours. The author has met this difficulty by the simple plan of coating the inside of the cell with cement, and his experience of this medium after some years and of some two thousand dry mounts, is that no sweating occurs when this material is properly manipulated. Ordinary sheet wax, the fresher the better, as when old it is brittle, and requires to be warmed, is placed in layers one above the other according to the desired thickness; and from these layers which are made to adhere by the heat of the hand, rings are punched out. Suitable punches devised by Mr. Whitney were described in the 'Proceedings' of the American Society of Microscopists for 1884.

The rings having been punched out are placed on a slide previously warmed and cleaned; pressure with the finger causing them to adhere to the glass firmly. The turntable upon which the slide had been placed for the previous operation is now revolved, and the inner and outer edges of the ring smoothed down with a penknife. When this is finished, a coating of some transparent cement is laid over the outer and inner surfaces of the ring. The varnish dries in a few hours, but it is better to leave them for a few days well covered up from dust. When the object is placed in the cell and secured by a minute drop of cement, a thin coat of cement is given to the top rim of the cell so that the cover will adhere firmly. The author then usually finishes off his mounts at once by putting on a coat of cement after the cover-glass has been fixed; for that purpose shellac varnish is

* Proc. Amer. Soc. Micr. 9th Ann. Meeting, 1886, pp. 153-6.

perfectly safe. If, however, the cement should tend to run in when the cover is applied, the finishing coat must be delayed for a few hours.

Mounting in Fluids.*—Mr. E. Ward writes on this subject as follows:—"There are some microscopic objects that we cannot mount, either dry or in balsam, nor yet in glycerin jelly, because the heat necessary to liquefy the jelly destroys the structure of the object. In such cases we must use fluid, but to seal up the fluid permanently is one of the difficulties of micro-mounting. I have been most successful in the way I purpose to show to-night. I first make a cell of brown cement, and allow it to harden thoroughly. I then spin a second ring of cement when just upon the point of mounting any suitable object; then fill the cell with water or other fluid, and arrange in it the object: place the cover-glass gently down, and fix with a clip just strong enough to hold it in position without causing any convexity, and absorb the exuded moisture by means of blotting-paper. After the clip has remained for an hour or so it may be removed, and another ring of brown cement spun over the junction of cell, slip, and cover-glass. This will make all secure. Brown cement is not suitable if used by itself for any fluids containing alcohol, because the spirit has some action upon this medium. In this case the cell, after being made in brown cement, should be covered entirely with balsam and benzole, and when dry this is again made tacky by a thin line of balsam, which fastens down the cover-glass. A ring of brown cement may be spun over all, and completely seal the mount, which may be afterwards finished in any way desired."

Media for mounting very perishable Artificial Crystal Sections.†—By very perishable crystals Prof. C. Johnston means such as lose their polish or become opaque in Canada balsam as well as in air. Examples of these are potassium and sodium tartrate, potassium nitrate, ammonia-sodium tartrate, and potassium and ammonia-sodium tartrate. Plumbic acetate is especially prone to undergo decomposition. A mounting medium should be transparent, and if possible colourless, enduring as such; of an index of refraction having reference to the substance treated; free from moisture, and not a solvent of the matters it is employed to defend. The author mentions the following as especially worthy of attention.

(1) Finest gum copal dissolved in chemically pure amylic alcohol. (2) Finest gum copal dissolved in chemically pure absolute alcohol. (3) Dammar resin dissolved in rectified spirits of turpentine. In making these solutions no heat is to be used. The gum copal should be broken up to the size of buckshot, set in a warm dry place for a while, and then having been placed in a well dried bottle to the extent of two-thirds its capacity, alcohol is poured in until the bottle seems half full. The bottle is then corked and the solution is left to time. The resultant fluids should be very thick. The absolute alcohol solution is highly transparent, the amylic slightly opalescent. The dammar solution is made in an analogous manner. (4) Dammar resin dissolved in well boiled copaiba balsam. To this latter, number 3 dammar solution is added, and melted by heat until the solution becomes very thick. On cooling it thins and is ready for use. It is of a dark sherry colour but quite transparent, and a preservative of crystalline films as ethel ether of gallic acid. (5) Boiled Chian turpentine dissolved in boiled balsam of copaiba. The turpentine is boiled until, when cold, it becomes nearly hard. The boiled copaiba and the turpentine are then melted together, until the mass, when cold, is too thick to flow.

* Trans. and Ann. Rep. Manchester Micr. Soc., 1886, p. 69.

† Johns-Hopkins Univ. Circ., vi. (1887) pp. 79-80.

The colour is a dark sherry, but the medium is transparent and brilliant, and is excellent for sections of potassium nitrate made parallel to the axis.

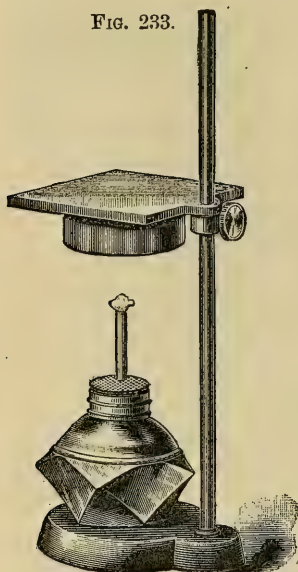


FIG. 233.

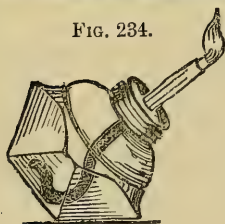


FIG. 234.

Solution number 1 is suitable to perishable crystals, as plumbic acetate, Rochelle salt. Number 2 is best fitted for attaching crystals or sections of any kind, or for holding sections to be ground very thin. Number 3 is preferable to Canada balsam on account of its white colour. It serves well to mount separately halves of the same crystal section, and is a capital cement for these two mounts when crossed. Numbers 4 and 5 are preferred by the author as they are perfectly free from humidity, and though darker than fresh Canada balsam, their tint does not deepen by time. A sixth medium, of which Prof. Johnston has had less experience, but of which he speaks favourably, especially for potassium nitrate, is made by boiling the whitest dammar until the scum is nearly dissipated; the rest of the scum is then spooned off. Rectified spirits of turpentine are then added till the proper tenuity is attained. It is then passed while still warm into a bottle, or the dammar having been boiled may be allowed to cool and then broken up into small pieces; these pieces are then put into a bottle and covered with rectified spirits of turpentine, the solution being left to time to accomplish.

Bausch & Lomb Optical Co.'s Spirit-lamp.—The peculiarity of these glass lamps is that they have nine facets, so that they can either be used upright on a mounting stand, as in fig. 233, or inclined as in fig. 234.

The size of the flame may be regulated by a sliding tube. In use the lamp is filled only one-third full.

BRIANT, T. J.—**New Form of Microscopic Cell** for mounting objects requiring to be examined on both sides.

[A piece of cardboard, the size of the usual glass slip, and having a circular aperture punched in its centre, is pasted between two similar cards with apertures slightly larger. A ring of Miller's cement is then run round the edge of the inner card, on one side of which a cover-glass is fastened, thus forming a fluid-tight cell. In this the object is placed, and is secured by another cover-glass, also fitting the aperture of the outer card. Objects mounted in this way may readily be examined with high powers, both on their upper and under surfaces.]

16th Ann. Rep. S. Lond. Micr. and Nat. Hist. Club, 1887, p. 12.

NEVILLE, J.—**New Form of Dry Cell.**

[“Made of vulcanite, which he had named the window-slide. This cell allows the cover-glass to be slipped on and off at pleasure, so that objects may be at once put up for examination, and dust or damp on the glass at any time removed.”]

16th Ann. Rep. S. Lond. Micr. and Nat. Hist. Club, 1887, p. 12.

PINCKNEY, E.—**Slide-Index.**

[Considers that the catalogues prepared by Ward and others may serve their purpose as a *record*, but not as an *index*. Every worker needs a reliable slide-index, to which he may turn for instant reference, and he therefore suggests the following:—Take a six-quire blank book, commonly known as “*record*” form, plain blue lines for writing and one vertical red line about one inch from left-

hand side of page. With a ruling-pen, draw a second similar red line, about half an inch to right of first one. This gives three spaces on each page. Now index the edges, giving each letter its due proportion. In the first space write the generic name, as *Amphipleura*, while in the third space you write the specific name, as *pellucida*, together with the number of the slide. The second space is for a key, or catch-word, and for this purpose a set of abbreviations is used.]

Microscope, VII. (1887) pp. 239-40.

(6) Miscellaneous.

BASTIN, E. S.—*Elements of Botany, including Organography, Vegetable Histology, Vegetable Physiology, and Vegetable Taxonomy.*

[Appendix treating of the Microscope, accessories, staining and mounting, fluids, and micro-reagents.]

300 pp., nearly 500 figs., 8vo, Chicago, 1887.

Bizzozero, G.—*Handbuch der Klinischen Mikroskopie, mit Berücksichtigung der Verwendung des Mikroskops in der gerichtlichen Medizin.* (Handbook of Clinical Microscopy, with reference to the use of the Microscope in Medical Jurisprudence.) Translated by Dr. S. Bernheimer, with a preface by Dr. H. Nothnagel.

2nd ed., x. and 352 pp., 45 figs. and 8 pls., 8vo, Erlangen, 1887.

COLE, A. C.—*Studies in Microscopical Science.* Vol. IV. Secs. I.-IV. Nos. 10, 11, and 12.

Sec. I. Botanical Histology, pp. 37-47. No. 10, X. Studies in Vegetable Physiology: Waste products. Glandular structures. (Plate 10. Resin glands from leaf of *Psoralea hirta*.) No. 11, XI. Glandular structures and crystals. (Plate 11. Petiole of Ivy.) No. 12, XII. Growth. (Plate 12. Young twig of *Aristolochia sipho* T. S.)

Sec. II. Animal Histology, pp. 37-50. No. 10. Reproduction in Snails. (Plate 10. Ovotestis of Roman Snail—*Helix pomatia*, Tr. S. \times 230.) No. 11. Reproduction and Development of the Liver Fluke. (Plate 11. Liver Fluke—*Fasciola hepaticum* \times 4.) No. 12. Reproduction in Tape-worms. (Plate 12. Tape-worm—*Tenia mediocanellata*, L.V.S. \times 12.)

Sec. III. Pathological Histology, pp. 37-46. No. 10. Kidney in Leucocythæmia. Leukæmic infiltration of Kidney. Hæmorrhagic Infarction. (Plate 10. Embolic Infarct of Kidney.) No. 11. Tubercular Renal Phthisis. (Plate 11. Tubercular Renal Phthisis.) No. 12. Epithelioma of the Kidney (Cancer of Kidney). (Plate 12. Epithelioma of Kidney.)

Sec. IV. Popular Microscopical Studies, pp. 37-51. No. 10. Growing-point of Stem Leaves. *Eucalyptus globulus*. No. 11. Seeds. (Plate 10. Seed of Sun Ray.) No. 12. Odontophores. (Plate 11. Odontophore of *Cyclostoma elegans*). *Tingis hystricellus*. (Plate 12. *T. hystricellus* \times 30.)

JAMES, F. L.—*Clinical Microscopical Technology.* VI.

[Urinary Examinations. Micro-clinical Reactions. Parasites and Fungi.]

St. Louis Med. and Surg. Journ., LIII. (1887) pp. 31-3, 100-2, 167-8.

JENNINGS, C. G.—*The Microscopical Examination of Urinary Deposits.* II.

Microscope, VII. (1887) pp. 202-4 (2 figs.)

[MANTON, W. P., and others.].—*Elementary Department.* Fifth and Sixth Lessons. "Cleanliness is akin to godliness."

[Section cutting and staining. Microtomes. Stains.]

Microscope, VII. (1887) pp. 211-4 and pp. 244-8.

(Cf. *St. Louis Med. and Surg. Journ.*, LIII., 1887, p. 99; comment on motto, which "wants reversing.")

M'CASSEY, G. H.—*Microscopy and Histology for Office Students.*

Arch. of Dentistry, 1887, May.

RAFTER, G. W.—*How to study the biology of a water supply*

19 pp., 8vo, Rochester, N.Y., 1887.

TAYLOR, T.—*Crystalline formations of Butter and other Fats.*

Microscope, VII. (1887) p. 239 (1 pl.).

WEINZIEHL, T. RITTER V.—*Die qualitative und quantitative mechanisch-mikroskopische Analyse; eine neue Untersuchungsmethode der Mahlproducte auf deren Futterwerth und eventuelle Verfälschungen.* (Qualitative and quantitative mechanico-microscopical analysis; a new method of investigation of food-products, with reference to their value as food and their possible adulterations.)

Zeitschr. f. Nahrungsmitteluntersuchung und Hygiene, 1887, July, 14 pp. and 1 pl.

PROCEEDINGS OF THE SOCIETY.

THE first Conversazione of the Session was held on the 24th November, 1886.

The following objects, &c., were exhibited:—

Mr. J. Badcock:

Lophopus cristallinus.

Mr. C. Baker:

(1) New Apochromatic Objectives and Compensating Eye-pieces by Zeiss. (2) Specimens of Bacteria. (3) Diatoms in Cassia Oil.

Messrs. R. and J. Beck:

(1) Petrological Star Microscope. (2) Bacillus of Leprosy. (3) Membrana Ruyschiana.

Mr. T. Bolton:

Eurycercus lamellatus.

Mr. Crisp:

Zeiss's 1/8 in. Apochromatic Homogeneous-immersion Objective.

Dr. Crookshank:

(1) Photomicrographs of Bacteria. (2) *Trichomonas Lewisii* from Sewer-rats.

Mr. H. Crouch:

Grand Model Microscope.

Mr. T. Curties:

Generative Organs of Insects, dissected by Mr. Tatem.

Mr. F. Enock:

Head of Ground Bee, *Colletes Daviesana*. Battledore-wing Fly, *Mymar pulchellus*. Fairy Flies, *Aclayrus incarnatus*.

Mr. F. Fitch:

Mouth structure of Fly (*Dexia*) and Ticks (*Ixodes*) from Madagascar.

Dr. Heneage Gibbes:

Photomicrographs.

Mr. H. F. Hailes:

Abnormal forms of *Peneroplis*.

Mr. J. D. Hardy:

Pond Life (various).

Dr. R. G. Hebb:

Actinomyces (Human) from Capillary of Liver.

Mr. S. J. McIntire:

(1) Pollen of *Victoria Regia*. (2) Seeds of *Pistia stratiotes*.

Mr. A. D. Michael:

Aglaophenia pluma (stained).

Mr. E. M. Nelson:

Amphipectura pellucida in Prof. H. Smith's medium, ref. index 2.4; oblique illumination by Powell's achromatic oil-immersion condenser; Powell's Oil-immersion Objective 1/12 in. N.A. 1.43 and 1/4 in. Huyghenian eye-piece, giving an amplification of 4400 diameters (equal to 36 times the initial power of the lens).

Messrs. Powell and Lealand:

(1) *Amphipectura pellucida* with 1/12 in. apochromatic homogeneous-immersion objective 1.40 N.A. and achromatic oil-immersion condenser. (2) Scale of Podura (*Lepidocyrtus curvicolis*) with 1/12 in. apochromatic homogeneous-immersion objective 1.40 N.A. and achromatic condenser.

Mr. G. Smith :

- (1) Rhyolite of Pre-Cambrian age, showing perlitic and spherulitic structure, Wrockwardine, Shropshire. (2) Pitchstone, Ponza Island, showing glass in a condition of strain. (Polarized light.)

Mr. J. H. Steward :

Hydra vulgaris.

Mr. C. Tyler :

Meyerina.

Mr. A. Topping :

- (1) Section of Hoof of Horse (double stained). (2) Palate of *Octopus* (double stained). (3) Earth Parasite, *Trombidium* (South Africa).

Mr. J. J. Vezey :

Ciliary Processes of the Eye of an Ox (injected).

Mr. H. J. Waddington :

- (1) Alloxanate of Ammonia (polarized). (2) Parabanic Acid (polarized).

Messrs. Watson and Sons :

- (1) Type Slides of British and Foreign Foraminifera. (2) Jaw of Mole, long. sect. through teeth. (3) Type Slides of Spines of *Echinus*, *Holothuria*, and *Synapta*.

Mr. T. Charters White :

Album of Photomicrographs.

The second Conversazione of the Session was held on the 27th April, 1887.

The following objects, &c., were exhibited :—

Mr. Badcock :

Lophopus cristallinus, *Floscularia*, &c., from Victoria Park.

Mr. C. Baker :

Apochromatic Objectives by Zeiss. Oil-immersion Objectives by various makers, especially suited for bacteriological work. New Photo-micrographic apparatus complete, with Nelson Model Microscope and Lamp, showing image of *Amphipleura pellucida* ($\times 3000$) projected on the focusing glass.

Rev. G. Bailey :

Foraminifer? from interior of Chalk Flint.

Mr. Bolton :

Tilmadoche nutans. Elver or young Eel. *Stentor polymorphus*.

Mr. Crisp :

Gold-plated Diatoms.

Mr. Enock :

Various Insects and parts of same, showing all organs in natural form and colour.

Mr. F. Fitch :

Mouth, Upper Lip, Gizzard, Ventriculus, and Pancreas of *Dytiscus marginalis*.

Mr. Hardy :

Marine Polyzoa, *Acineta*, and Insects' Eggs.

Mr. Ingpen :

Dendrosporgia and Diatoms mounted in Bromide of Antimony.

Mr. Karop:

Ciliary Muscles (*Homo*): left in Presbyopia, right in Emmetropia; both from normal eyes.

Mr. McIntire:

Circulation of the Blood in the Heart and Gills of the Tadpole of the Frog.

Mr. Maniland:

Pupa of *Cynips* (sp.) from leaf-gall on *Rosa canina*.

Mr. Michael:

Nothrus spiniger.

Dr. Millar:

Darwinella aurea: triradiate horny spicule.

Messrs. Nelson and C. L. Curties:

A new Photomicrographic Apparatus.

Messrs. Powell and Lealand:

Amphipleura pellucida with 1/12 in. Apochromatic Homogeneous-Immersion Objective and Achromatic Oil-immersion Condenser.

Mr. Priest:

Sponge Structure from interior of Flint found at Bexley in a gravel-pit.

Mr. Rousselet:

Circulation of Blood in Tadpole.

Mr. G. Smith:

Olivene Basalt: Boulder from Glacial Drift of Finchley. Trachydolerite. Twin Crystals of Orthoclase (v. Sanidine). Quartzite, the Wrekin, Salop.

Mr. Suffolk:

Lips of Blow-fly viewed by reflected light, showing entrance to throat, teeth, and exits of pseudo-tracheal canals.

Mr. Topping:

Various groups of Polycystina from Springfield, Barbadoes.

Mr. T. Charters White:

Photomicrographic Camera. Album of Photomicrographs.

1887. Part 6.

DECEMBER.

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JOURNAL OF THE ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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PREFACE.

THIS Journal has now completed the tenth year of its publication, since it was launched on the extended basis which was inaugurated after its first year, when it formed a volume of 402 pages only.

Throughout this period I have had no reason to complain of any want of appreciation, but on the contrary have to acknowledge a veritable load of congratulations of a very demonstrative character, not only from microscopists but from biologists generally who have recognized the value of a publication—the only one in the English language—which enables its readers to make themselves acquainted without delay with the contents of the enormously scattered literature of Biology and Microscopy throughout the world. It is the fact of this consensus of opinion that leads me to add this Preface to the present volume, as the approbation that has been showered on the Journal has not fully reached those who are most worthy of it.

In the case of a battle, it is perhaps necessary that it should pass as the victory of the particular general in command, however much it may have been due to the skilful arrangements of the commanders of divisions or to the general valour of the rank and file, but we are not trammelled by any such rules in the case of this Journal, and it is proper therefore to call attention to the extent to which its success is due to my Co-editors.

In the departments of Botany and Zoology, Mr. A. W. Bennett and Prof. F. Jeffrey Bell have now for ten years analysed the various papers which have been recorded in the Summary of Current Researches. No one who has not actually undertaken it can have any idea of the extent of the labour which this involves. My own preliminary work in advance of the actual analyses has required a certain amount of resolution to face week after week, but this labour has been very small in comparison with that undertaken by Mr. Bennett and Prof. Bell, who have had to read through the whole of the papers and then to produce those analyses which have appeared in number after number. Moreover, the length of the notes is practically in inverse proportion to the difficulty of writing them. It is easy to produce an extended abstract;

the difficulty is to condense the leading ideas of the author into a brief compass, so that any one who desires to know its scope, and to determine whether it is desirable to refer to the original paper, can have before him the necessary guidance. All this has been done by Mr. Bennett and Prof. Bell, with an amount of skill and with a degree of regularity which at the outset I could not have believed possible. What is still more remarkable, is the punctuality which has been observed throughout. In no single instance has the MS. been received after the appointed time; in most cases it has been in advance of time. A striking testimony to what has thus been accomplished is to be found in the view of an eminent biologist, who, in the earlier days of the Journal expressed the opinion that the Summary must necessarily in a short time "run thin": the same biologist last year spontaneously declared that "the Journal got better and better." I claim therefore for Mr. Bennett and Prof. Bell that botanists and zoologists owe them a large debt of gratitude for the good work they have done with so much self-sacrificing perseverance.

The Microscopical division of the Journal is in like manner indebted to Mr. J. Mayall, jun., for a large amount of assistance which for the same length of time he has rendered in this department, assistance of such a character that without it it would have been impossible to produce the varied assortment of matter which has kept microscopists so fully, and I may say so completely, informed as to all that is novel, interesting, or curious in the various sections of the subject.

I have left unnoticed the services of Mr. J. Arthur Thomson, who has recently undertaken, with no little success, a part of the Zoology, and of Dr. Hebb, who has practically had complete charge of the Technique section, with what result the pages of the last two volumes of the Journal abundantly show. This omission arises from the fact that I have been dealing not only with the quality of the services rendered by the three senior Co-editors, but also with the remarkable length of time over which those services have extended, and in which respect they at present stand alone.

It is to be hoped that the increased circulation of the Journal outside the Society may allow of some adequate return in a substantial form being made to the Co-editors, and pending the arrival of the day when that will be possible, I tender to them not merely my own thanks but those of the Fellows of the Society at large, and I hope and believe those of a still wider circle of biologists and microscopists also.

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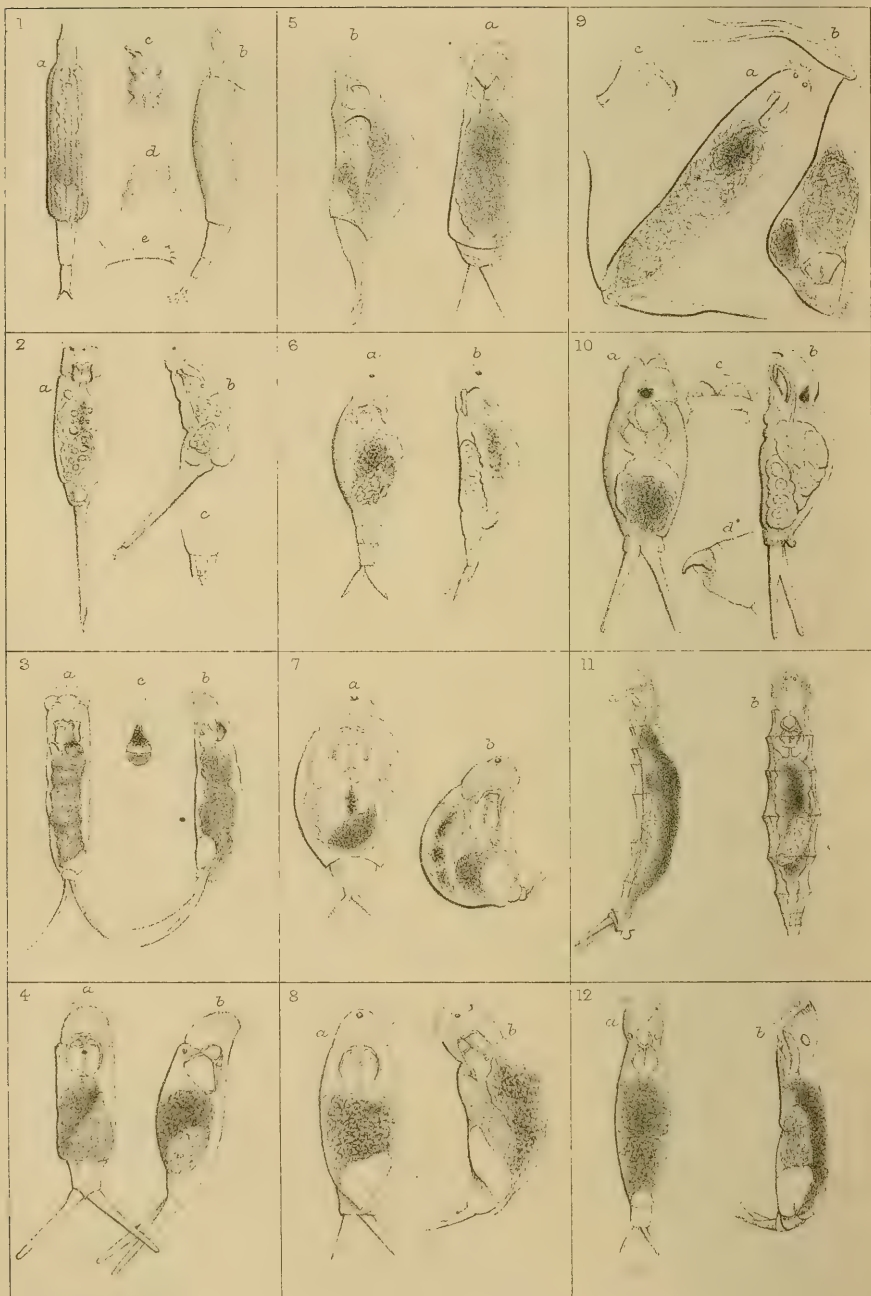
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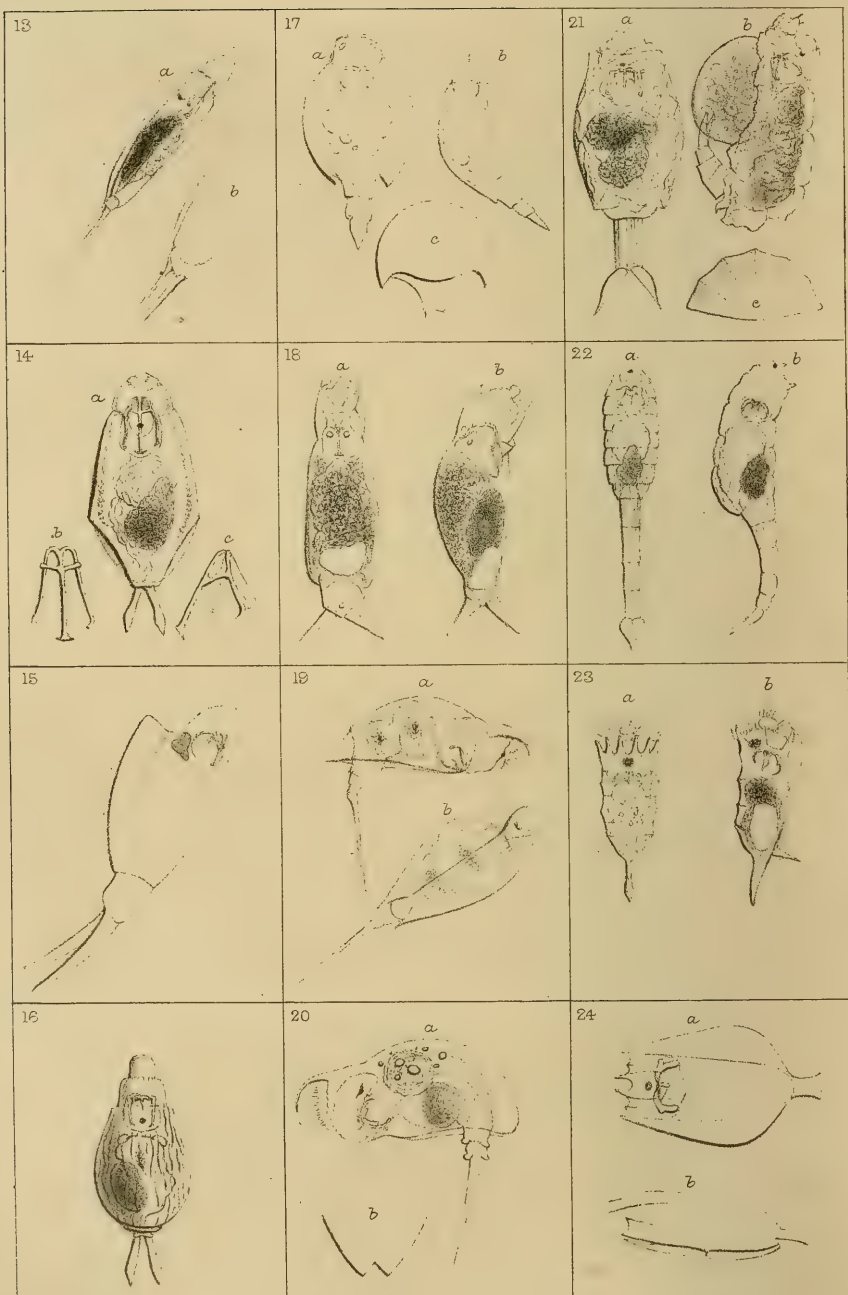
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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

DECEMBER 1887.

TRANSACTIONS OF THE SOCIETY.

XIII.—*Twenty-four more New Species of Rotifera.*

By P. H. GOSSE, F.R.S., Hon. F.R.M.S., &c.

(Read 12th October, 1887.)

PLATES XIV. AND XV.

RECENT investigations having still further augmented the list of our native Rotifera, I am enabled to present to the Society diagnostic descriptions and delineations of twenty-four new species.

1. *Philodina microps*. Body very slender, closely resembling *Rotifer vulgaris*, both in form and manners, but with eyes distinctly pectoral, small, round, of very pale red hue. Column thick, rounded, with minute hooked proboscis at front: spurs rather small, separated by a horizontal edge: corona in action not wider than head. Length 1/80 in. Marine.

This can scarcely be confounded with any recorded *Philodina*. For some time I felt sure it was *Rotifer vulgaris*, and marvelled that I could

EXPLANATION OF PLATES XIV. AND XV.

Fig. 1.—*Philodina microps*. a, dorsal; b, lateral; c, corona expanded; d, retracted; e, antenna.

Fig. 2.—*Notommata Theodora*. a, dorsal; b, lateral; c, foot retracted.

3.— „ *linax*. a, dorsal; b, lateral; c, brain and eye.

4.—*Proales coryneger*. a, dorsal; b, lateral.

5.—*Furcularia lactistes*. a, dorsal; b, lateral.

6.— „ *molaris*. a, dorsal; b, lateral.

7.— „ *sphærica*. a, dorsal; b, lateral.

8.— „ *sterea*. a, dorsal; b, lateral.

9.— „ *Eva*. a, dorsal; b, lateral; c, mastax, from the right.

10.—*Diglena aquila*. a, dorsal; b, lateral; c, beak, dorsal; d, lateral.

11.— „ *Rosa*. a, lateral; b, dorsal.

12.—*Distemma platyceps*. a, dorsal; b, lateral.

13.—*Mastigocerca Iernis*. a, lateral; b, foot-bulb enlarged.

14.—*Diaschiza fretalis*. a, dorsal; b, trophi dorsal; c, *ib.* lateral.

15.— „ *acronota*. Lorica, lateral.

16.—*Distyla lipara*, dorsal.

17.—*Metopidia pygmaea*. a, dorsal; b, lateral; c, transverse section.

18.—*Dispinthera capsæ*. a, dorsal; b, lateral.

19.—*Monura Bartonia*. a, lateral; b, ventral.

20.— „ *loncheres*. a, lateral; b, posterior sinus.

21.—*Mytilia pœcilops*. a, dorsal; b, lateral; c, transverse section.

22.— „ *producta*. a, dorsal; b, lateral.

23.—*Anuræa schista*. a, dorsal; b, lateral.

24.—*Notholca labis*. a, dorsal; b, lateral.

not see the eyes in the column. But when I looked to the *pectus*, they were plain enough, though very pale. I know no other species, whether of *Rotifer* or *Philodina*, with so very small a corona in rotation. The whole trunk is fluted. The viscera are tinged with pale smoke-brown, deepest in the abdominal canal. In some examples the hue is rather of a chestnut-brown.

I have examined perhaps half-a-dozen specimens, inhabiting the conferva of marine rock-pools in the Firth of Tay. The species is very shy of rotating, thus differing from other *Philodinæ*, which are characteristically free. At the moment of extruding the column, its broad extremity opens a central orifice (*d*), which is strongly ciliated around its margin, while a row of cilia, apparently *few* and *distant*, is seen fringing the outer edge. The antenna (*e*) consists of (two?) telescopic joints, its extremity dilated, carrying four divergent setæ. (Fig. 1, plate XIV.)

2. *Notommata Theodora*. Near to *N. aurita*, *naïas*, and *potamis*; from all which it differs in that the eye is small, and quite frontal, while the slender straight foot is protrusile to an immense length, or wholly retractile. Length, when fully extended, about 1/60 in. Lacustrine.

A noble form, of great elegance, and of glassy clearness; colourless, save for a tinge of pale-orange in the tissues of the head (frequent in the kindred species), and the occasional hue of the contents of the stomach. The body has the massive aspect of the species named, but the position of the eye is notable, close to the frontal edge of an ample brain. The form and extreme versatility of the foot, too, are quite peculiar. Sometimes the body is truncate behind, and only the tips of the tiny toes are seen protruding from the hyaline cavity (*e*); when, with lightning suddenness, the foot, like a slender rod of glass, is shot out to a length equalling the whole trunk; and so carried, while the animal darts along with headlong swiftness. The only parallel to this, that occurs to me, is the case of *Rotifer macrurus*. The toes are often turned suddenly, to the right or left, at a joint just above them, the long foot else preserving its perfect straightness. When smoothly swimming, the front often appears as if *auricles* were on the point of developing, but I have not seen them extruded. In retraction the front often becomes pursed-in at the middle. (Fig. 2.)

3. *Notommata limax*. Body vermiform, integument soft; alimentary canal ample, thrown into apparent annulation by alternate constrictions and swellings: brain having a globose terminal bulb partly filled with opaque chalk-masses, and partly with a large eye: foot-bulb contained within the body; toes long, slender, acute, decurved. Length 1/173 in. Lacustrine.

The slug-like softness of the skin gives this species some resemblance to *Diglena permollis*; but it is less versatile in outline. The brain recalls *N. aurita*, the ample sac having a slender tube running through it occupied with opaque specks, which terminates in an ovate expansion. This is, in part, opaque with chalk deposits, and its rounded extremity is filled by a large crimson eye (*c*). There is a likeness to *N. cyrtopus* in the toes; but the general facies is very diverse. Swimming it will suddenly augment its speed by pushing out for an

instant a pair of auricles. There is a distinct tuberculous tail. The whole animal is tinged with pale-yellow. I have seen two examples in *Utricularia* from a lough near Carrick-on-Shannon. (Fig. 3.)

4. *Proales coryneger*. Body nearly cylindrical, rounded in front and rear: foot stout, apparently one-jointed; toes two, furcate, rod-shaped, thick at base, tapering to an obtuse point, very slightly recurved, half as long as body-and-head. Length $1/130$ in. Lacustrine.

This obscure form I cannot, on the evidence of a single specimen, identify with any species known to me; though I own it presents little distinctive character. Its long, thick, club-shaped toes form its most obvious distinction: these are usually carried *wide apart*. The figure suggests *Diaschiza*; but I could not detect any dorsal fissure, and the soft skin seems destitute of a lorica. There is a minute red eye in the occiput. In swimming it is rapid, smoothly gliding; darting to and fro, without any appreciable aim. It, like the following, occurred in the swift mill-stream of Kingskerswell. (Fig. 4.)

5. *Furcularia lactistes*. Back much arched, soft and plump, smooth, round: foot stout; toes long, slender, acute, decurved; foot and toes together equal in length to the trunk: a short pointed tail. Length $1/175$ in. Lacustrine.

It possesses much elegance of form, and a most restless activity, every instant retrojecting the long foot and toes, with the action of a kicking horse, very forcibly and pertinaciously. It has one very curious habit: it constantly insinuates itself between two stalks of conferva, where it immediately begins to make itself a cell (only just large enough to hold it) by incessantly turning *head over heels*. As soon as it has got its place, it bends the front down to the belly, and begins to roll round and round, without a moment's cessation, for hours. If forced out, it at once begins the same process somewhere else. The habit, which is not that of an individual, but is characteristic of the species, may be compared with the tube-making propensity of *F. forficula* (See H. and G. Rotif. ii. 40, 41). In other respects it has the manners of its genus; as in its sudden and rapid motions, its volutions, and its swift shooting way of swimming. The incus-fulcrum appeared to be a massive pillar, with long, slender, divergent, arching rami: the mallei evanescent.

I met with several examples of this interesting species, inhabiting floating tufts of a floccose conferva, that waved in a rapid rivulet in the village of Kingskerswell. And, a few weeks later, two more occurred in water from Carrick-on-Shannon, Ireland. These had the same form, and identically the same habits, as the Devonshire specimens. And, more recently, I have detected the species in other waters. (Fig. 5.)

6. *Furcularia molaris*. Body ovate, with a thick truncate head, and suddenly diminishing to a long foot, terminated by two blade-shaped, straight, acute toes: back elevated; belly straight. Length $1/240$ in. Lacustrine.

A single round eye, well-defined, of ruby brilliance, near the frontal part of a clear saccate brain, marks this rather insignificant species. The trophi are nearly as in *F. lactistes* just described; but the mallei are more developed. An ample alimentary canal, undivided, nearly fills the trunk; and a clear ovary crosses it obliquely, having in

general embryonic vesicles more or less conspicuous. The long foot and toes are carried straight behind, and both extended are about as long as the trunk. It is, as usual, restless, moderately swift, with a smooth gliding course. It is an elegant and attractive little species, which, for lack of any very marked characteristics, I name from the locality in which I found it, — the Kingskerswell mill-stream. Here, on different occasions, I have met with several examples. (Fig. 6.)

7. *Furcularia sphaerica*. Body globose dorsally, nearly flat ventrally: foot short, thick; toes small, straight, acute; the dorsum projecting over them with a slight rim or margin, which, laterally seen, looks like a tail. Length $1/240$ in. Marine and lacustrine.

In lateral aspect this pleasing little form may easily be mistaken for a deep *Colurus*, till the trophi reveal its true Furcularian character, confirmed by a minute ruby eye at the extreme front; as also by its motions. The head seems not retractile. I first formed acquaintance with it, in half a dozen examples on different occasions, from tide-pools in the Firth of Tay. Then a specimen, recently dead, occurred in fresh water among *Myriophyllum*, thickly studded with *Melicerta ringens* and *Flosecularia cornuta*. And presently, to confirm the amphibious habitat, I found one alive in *Utricularia* from a lough in the centre of Ireland. These fresh-water specimens I could in no wise distinguish from the marine. (Fig. 7.)

8. *Furcularia stercora*. Body ovato-cylindric, with a thick truncate head, and subprone face; behind ending in a short, decurved, acute tail: foot short and thick, apparently one-jointed; toes moderate, acute, scarcely decurved. Length $1/173$ in. Lacustrine.

Having much in common with *F. molaris*, this is yet quite diverse in facies and habit. The head is of nearly the same thickness as the trunk; the little overarching tail (seemingly a stiff point), and the short but massive foot, are differences that strike one at first sight. The eye is distinct, quite prominently frontal; immediately beneath it the face recedes, and becomes a subprone ciliate surface, applied to the feeding-ground. It is much larger than *F. molaris*. The single specimen seen had a great contractile vesicle, and a small undeveloped ovary. The stomach seemed undivided. The fore-parts were tinged of a delicate yellow hue. It was not much addicted to swimming, but crept vivaciously about the vegetation, grubbing and browsing. I obtained it in water from a little rockery-pond in the grounds of Watcombe Park, the beautiful estate of Colonel Wright, near Torquay. (Fig. 8.)

9. *Furcularia Eva*. Body stout, fusiform, strongly elevated on the shoulder: foot short, indistinct; toes more than half as long as body-and-head, thick for half this length, then abruptly attenuated for the remainder. Length $1/144$ in. Lacustrine.

The great length and peculiar form of the toes, which are often thrown back and carried over the back, give a facies to this rather fine species, which at once strikes an observer. Sometimes these organs are extended in opposite directions in a horizontal line, imparting to the animal the figure of the letter T reversed. The mastax is ample; the incus a thick rod, bent in the middle backwards, and ending occipitally in a pair of long and broad scythe-shaped processes: the mallei indistinct.

A slender brain descends behind; but no eye is visible, unless two very pale globules, close side by side, in the very front, are such.

A single specimen only has occurred, whose activity mainly consisted in the vigorous throwing into different positions of the characteristic toes. (Fig. 9.)

10. *Diglena aquila*. Body fusiform: head furnished with a beak: foot short, thick; toes nearly as long as trunk, thick to half-length, then diminished to stiff, straight rods with obtuse points. Length $1/65$ in. Lacustrine.

The long straight blunt toes are very characteristic. The proboscis is a broad shield, somewhat as in *Stephanops*, permanent, surrounded by a ring of very long vibratile cilia. It forms, indeed, a hooked beak, shaped like that of an eagle, the edges of which, converging to a point (*c*), are distinctly visible from above, through its hyaline substance.

In manners it is headstrong, abrupt, vigorous; most restless, never pursuing one course more than an instant, but suddenly stopping, and turning round on itself, augmenting its speed greatly for a moment, rushing, or rather *shooting*, forward for three or four times its length, then again and again, but never springing sidewise. I first received it from the middle of Ireland, by the kindness of Mr. Hood, jun.; then in a pond near my own residence; and on several occasions since.

It bears a very close resemblance to a species discovered by Mr. E. C. Bousfield, of which he courteously sent me a drawing, under the name of *Notommata rapax*. This has two conspicuous styles (antennæ?) projecting straight from the head, which I do not see in *D. aquila*. If, however, the two are identical, his specific name has the priority.

None of my earlier examples showed any trace of an eye-spot; but since this article was written I have met with a specimen, in another missive from Mr. Hood, jun., in which was conspicuous a very large black occipital eye, if, indeed, it was not an opaque chalk-mass of the brain. (Fig. 10.)

11. *Diglena Rosa*. Body lengthened, fusiform, annulose, larva-like: proboscis frontal, beak-shaped, within which are two colourless eyes: foot minute; toes small, straight, acute. Length $1/150$ to $1/115$ in., average width $1/475$ in. Lacustrine.

The strong division of the body into annular false-joints recalls *Taphrocampa*. The head, too, resembles that of an insect-larva. The frontal beak is broadly triangular, like that of *D. aquila* just described, and its sharp point, hooked downward, can be seen from above, through its transparent substance. Two well-defined, perfectly colourless bodies, side by side, are also seen through the base of the beak, apparently eyes without pigment. A ring of close-set cilia surrounds the front, behind the base of the beak. The face is truncate, studded with warty eminences. The body terminates in a distinct bulbous tail.

Several examples occurred in conferva-tufts waving in the swift mill-stream at Kingskerswell. All were of a clear horn-yellow hue, with the long alimentary canal full of opaque food-matter. They were restless and swift;—the jaws often protruded from the face, *more generis*. The beak was much more acute and better-shaped in some than in others.

Numbers 2, 9, and 11 of the present series I owe to the kind efforts

of three young ladies, the lovely and accomplished daughters of R. W. Beachey, Esq., of Kingskerswell. I have honoured these three species with their names, as an expression of gratitude for the zeal with which they have kept me supplied—themselves skilful microscopists—from the waters within their reach. Each of these three species was discovered in the prolific mill-stream so often mentioned in this article. (Fig. 11.)

12. *Distemma platyceps*. Body subfusiform; belly flat; head broadly truncate: eyes two colourless globules, remote, occipital: foot rounded; toes taper, acute, slightly decurved. Length $1/144$ in. Marine.

Though not unlike certain conditions of *Diglena suilla* and *permollis*, this is distinguished by its two large colourless eyes; and by the fact that while the trophi are of the usual *calliper*-form, the mallei are (or seem) attached to the bases, rather than to the ends of the circular rami; while the fulcrum is nearly as long as the mallei. An inconspicuous hooked proboscis is present, which appears retractile. The broad face is of hyaline delicacy, free from corrugations and marks, as if clear gelatinous flesh, and this well defined from surrounding tissues, in all aspects.

Young specimens are very restless and mobile, but an adult was of slow movement. Five or six examples occurred to me in water from a tide-pool near Carnoustie, in Forfarshire. In one the jaws were about half extruded from the face, and (as if by paralysis) could not be retracted, or even moved:—an accident, the occurrence of which I have observed on repeated occasions, in predatory Rotifera. The species is numerous also in a ditch near Goodrington, South Devon. (Fig. 12.)

13. *Mastigocerca Iernis*. Body long-oval; a low dorsal ridge throughout, rising abruptly with an oblique edge in front: toe not so long as lorica; sub-styles two, unequal, the chief one about one-third as long as the toe, remote from it at the base. Length $1/80$ in.; of head and body, $1/173$; of toe, $1/185$. Lacustrine.

This species has much resemblance to *M. scipio*; but the regular form of the lorica, and that of its ridge; and the origination of the toe and of the main sub-style, on opposite sides of the foot-bulb, so as to be remote from each other,—seem sufficient peculiarities to warrant its distinctness.

Several examples have occurred in *Utricularia vulgaris*, sent me by Mr. W. R. Hood from a lough in the heart of Ireland. Most of these were dead, mere empty loricae, affording excellent opportunities for precise observation and delineation; others were alive and active. I subsequently found it in water from Cannock Chase, sent by Mr. Bolton. The distinctive characters noted above were conspicuous in all; as also in some vigorous examples from Perthshire. In these the extremities of the jaws were occasionally protruded. I detected, moreover, on the front, three tubercles (one central and two lateral), which seemed fleshy, extensile, and retractile. (Fig. 13, plate XV.)

14. *Diaschiza fetalis*. Lorica pyriform in outline, viewed dorsally; gibbous laterally; each plate cut off obliquely behind, and somewhat excavate: belly nearly flat: toes long, blade-shaped, regularly decurved, acute: head furnished with a beak-like projection. Length $1/185$ in. Marine.

This form comes very near to *D. rhamphigera*, but the oblique excavation of each of the dorsal lorica-plates is much more distinct, the frontal beak is more slender, nearly evanescent, and does not appear to be a prolongation of the trophi, which, moreover, are somewhat diversely shaped. There is a red eye on the inner surface of the brain, which I did not perceive in *D. rhamphigera*; and, above all, it is marine.

Only a single specimen has been observed, and that dead; but so recently as to leave the internal organs and viscera well-defined, and *in situ*. It was from a tide-pool at Invergowrie. Both species, if they are distinct, require further study. (Fig. 14.)

15. *Diaschiza acronota*. Lorica much elevated, heart-shaped in lateral outline; the dorsal cleft very manifest: head globose, prominent: foot thick; toes stout, long, nearly straight, tapering: eye occipital, pale, very large. Length $1/140$ in.; depth $1/400$. Lacustrine.

This very remarkable form is another novelty yielded by the mill-stream at Kingskerswell. It seems a very distinct and interesting species; though known, as yet, only by a single dead specimen, in which the eye and the trophi remained in position. The eye is a remarkable feature, from its great size, irregular shape, and pale hue. It occupies nearly half the vertical depth of the body, of a very pale salmon-red. In all these points it resembles the organ in *D. pæta*. The mastax is small: the toes have a backward curve, so slight as to be scarcely perceptible. (Fig. 15.)

16. *Distyla lipara*. Lorica skin-like, flexible, plicate: body flask-shaped, soft and very plump, not pointed behind: toes large, blade-shaped, not shouldered: brain simple; eye minute, occipital. Length, total extended, $1/162$ in.; of lorica alone, $1/260$ in.; but being very flexible, it contracts to $1/350$ in. Lacustrine.

This differs, at sight, from its known congeners by its round, manifestly soft, body, properly egg-shaped, specially in its hind parts, scarcely at all flattened, and destitute of the usual inangulation; the edges of the dorsal and ventral plates approaching close in the middle, and diverging at both extremities, so that the rounded surface is scarcely broken. The soft integument is constantly thrown into deep irregular plicæ, which do not appear to be permanent. A great foot bears, on a condyliform joint, two toes which are widely blade-shaped, longer than the mastax, acute, but not in the least shouldered at the tips. They are habitually thrown up under the belly. The eye is minute, pale-red, occipital. The trophi are normal, long, and capable of being brought to the very front, where they work vigorously. The whole head is protrusile, and very mobile.

The entire animal is transparent and nearly colourless; but the numerous folds and corrugations impart an appearance of a blue-black tinge to the body. The form and outline are subject to slight but continual changes, contracting and expanding. The animal is lithe and active, but not locomotive. A single specimen has occurred in water from Sutton Park ditch, Birmingham, in the orange-coloured sediment which abounds with fine Desmidiæ. (Fig. 16.)

17. *Metopidia pygmæa*. Lorica ovate, much elevated, the back rounded, the edges overhanging; hind margin rounded; ventral surface

flat: foot stout, long; toe apparently single, small, acute. Length, extended, $1/350$ in.* Lacustrine.

This seems the smallest of the genus; smaller than *emarginata*, or than *triptera*, which latter was in sight at the same time, for comparison. It is very transparent and colourless, the viscera only just discernible; the trophi, though working, were but shadowy lines. The extremity of the lorica is neither pointed, nor sinuate, but evenly round: its overhanging margins are remarkable, recalling *Notholca scapha*. There are two clear colourless globules at the very front, remote from each other, probably eyes. The frontal hook is carried rather close to the front, and seems incapable of independent motion; it is visible in a dorsal view, as a line parallel to the front. Two minute air-bubbles were in the alimentary canal of the individual examined; but no particles, nor stain, of food, though the tiny creature was industriously picking all the time it was under observation,—an hour or more. It was active and restless, creeping about the floccose, but rarely swimming, and then laboriously. A single specimen occurred in a phial of *Utricularia* sent by Mr. W. R. Hood, from the middle of Ireland. (Fig. 17.)

18. *Dispinthera*, gen. nov., Fam. *Coluridæ*. Gen. Char.—Body sub-cylindric, inclosed, in part, within a lorica open in front and in rear, apparently cleft down the venter: head and foot habitually protruded: head distinct, protected by horny plates, but without a frontal hook: two cervical eyes.

D. capsæ. Lorica in most parts soft and flexible: foot stout; toes two, furcate, thick, straight, tapering, acute. Length $1/250$ in. Lacustrine.

This apparently new form I found in the sediment of water dipped by Mr. Bolton from “ditch No. 2,” in Sutton Park, Birmingham, crowded with fine Desmidiæ. The facies strikes one as very peculiar, and difficult to explain. The front is capable of much protrusion, in a conical form, where a globose tubercle is visible, but only occasionally; and a similar one, but more constant, on the occiput (or rather crown of the head), just below the point of the occipital sheath. The lorica is discernible chiefly about the head; it there projects into several points, which seem very flexible, but constant. When the head is far retracted (which is seldom), an array of spears is left bristling up. Now and then, at the pectus, the integument is seen to fall into a flap, or hanging lip, to be presently withdrawn. The principal shield protects the back of the head, but does not form an arching hood, or frontal hook. The trophi, in several good views, seemed of the pattern (fig. 39 of my paper “On Manducatory Organs,” Phil. Trans. 1856); assigned to *Notomm. gibba*. The whole facies recalls one of the smaller *Notommata*; yet the two well-defined eyes remove it from them; besides the manifest lorica. It seems to approach the marine genus *Mytilia*, but not very close.

Only a single specimen occurred, in June. It was active and busy, constantly turning and wheeling about, but little given to locomotion.

* The figures in the plates are not drawn to one scale; if they were, this would be not one-fourth as long as No. 13 on the left of it. Each figure is drawn as the containing area will permit, the object being to show as much structural detail as possible.

It suggests the odd notion of a creature carrying its great clumsy head in a bandbox. (Fig. 18.)

19. *Monura Bartonia*. Lorica ovate, moderately compressed, dorsal outline (viewed laterally) one-third of a circle, ending in triangular points, which have the dorsal side slightly excavate: one eye frontal: toe straight, slender, acute, more than half as long as the lorica, shouldered dorsally. Length, from frontal hook to tip of toe, $1/173$ in. Lacustrine.

The genera *Colurus* and *Monura* (if, indeed, they are not one) appear to contain a large number of species, peculiarly difficult to define satisfactorily. Yet this and the following are, I think, to be distinguished. The toe and foot together are nearly equal in length to the lorica. I could find no trace of a median line in the toe. Its extreme length and tenuity are notable. Each posterior point of the lorica forms an equilateral triangle, clearly defined from the general area of the lorica, by a line—the base of the triangle. These two triangular termini are of excessive delicacy, and may easily escape a cursory notice. On the extreme front, under the frontal hook, is a small dark crimson eye, like a wart on the face.

Its manners are those of so many of its fellows, remaining long totally withdrawn between the closed lorica-plates in front, pivoting and swaying on the toe-tip incessantly for hours. I first obtained it, in the spring of this year, from a pond known as the Reservoir, at Barton, near Torquay. Since then I have met with single specimens from many localities, and in abundance in the Kingskerswell mill-stream. (Fig. 19.)

20. *Monura loncheres*. Dorsal outline narrowly ovate, lateral nearly semicircular; lorica rounded behind, with a median angular notch: toe shouldered dorsally, excessively long and slender. Total length $1/200$ in.; vertical depth $1/550$ in. Marine.

The most striking points in this beautiful species are its great depth (from back to belly), making about a half-circle, and the tenuity of the toe, which seems indivisible. This runs to so exceedingly fine a point as to escape notice, except with the most delicate focusing; even with a quarter objective, and the best possible light. The foot, of two condyli-form joints, and the toe, together, are fully equal to the lorica in length; viz. $1/400$ in. The ventral cleft is narrow, straight-sided, slightly approximate in front, and reaching round to the occiput, posteriorly to a short acute sinus (*b*), whose sides form a right angle. There is a brilliant ruby eye about the middle of a saccate brain, and therefore cervical.

I have examined a number of examples, at different times, in sea-water obtained by Mr. Hood from the Invergowrie tidepools. In one of these I timed the period of emptying the contractile vesicle to be just three minutes. It had this peculiarity, that the emptying was but partial on each occasion: that the bladder suddenly diminished its volume, but not to a point, nor nearly. The animal's posturing manners are exactly the same as described in the preceding species. (Fig. 20.)

21. *Mytilia pæcilops*. Lorica pergamentaceous, very flexible, constantly thrown into irregular folds, whence the outline is very variable: the face, in particular, is capable of great protrusion in wide plicate membranes: prevalent figure, foot, and toes, much as in *M. Teresa*. Length of lorica $1/240$ in.; depth $1/480$ in. Marine.

Though this has many features in common with *Tavina* and *Teresa*, particularly the foot and toes, it has important peculiarities. The *dorsal* outline is like that of the latter, the lateral that of the former; but *both* more rough and uncouth. The skin thrown irregularly into coarse rude folds, occurring at intervals at every part, precludes any fixed form, so that the figure accurately copied has become in a few minutes, though gradually, flagrantly incorrect. The front is large and broadly truncate, capable of pushing out, from its lower part, great membranous sacs and folds, which slowly change every moment, and the use of which is inexplicable. These expansions do not appear to be ciliated. The mastax and trophi are as in its congeners; there is an ample brain, which carries a cervical red eye. The whole back is ridged, —tectiform, not keeled (*c*).

I have observed numerous examples in sea-water from the Invergowrie tide-pools. They have all been remarkably heavy and sluggish in manners, little given to locomotion, wholly lacking the sprightly vivacity of the kindred species.

With one of these specimens a curious phenomenon occurred, which I cannot at all explain (see *b*). The animal was jerking and shaking itself, as if either wishing to be free from an annoyance, or else tearing some prey. Having got it somewhat turned, I saw that it carried, between its bent-up foot and its much developed face, what appeared an *egg*, of dark granular substance, as if just laid, of a pointed-oval form, reminding me, in shape and spotting, of a tern's egg. Whether it was a real egg, or no; if so, whether its own;—I could not tell. It appeared uninjured; and was firmly held for several hours,—as long as the *Mytilia* lived. By-and-by the interior of the “egg” displayed many clear circles (of which I could count about twenty), closely like the nucleated embryonic vesicles often seen in the ovary;—a fact which adds to the inexplicability of the phenomenon:—for they certainly were not visible at first. Another thing was remarkable. The carried “egg” had sensibly become less in bulk, while it retained its perfect form and outline; yet it had not been sucked, for the *Mytilia's* mouth was not, nor had been, in contact with its surface. After three hours, the egg was not more than one-third of its original bulk. Unfortunately no further change occurred during the lapse of a night; the next morning both the animal and the egg were unaltered in appearance, and the former evidently dead. The species seems unusually intolerant of captivity. The abdominal viscera are generally of a rich orange-brown hue, and the whole tissues are more or less suffused with the same colour. (Fig. 21.)

22. *Mytilia producta*. Skin flexible, plicate: body slender, very extensible: eye single, frontal: foot and toes nearly as in *M. Teresa*. Length 1/100 in. Marine.

The lorica, flexible in *M. pæcilops*, is perhaps even more so in this species, and recognizable only at the posterior extremity, where each lateral plate can be traced, as, with a rounded end, it curves under the trunk, to approach its fellow-plate, leaving a narrow ventral cleft. The face is quite truncate, slightly oblique, not abnormally developed. When gliding rapidly along a seaweed, the animal is very worm-like, the body and the foot, about equal in length, forming two successive cylinders,

the latter half as thick as the former. But both, especially the foot, are capable of sudden elongation at will. Thus the creature has a facies which distinguishes it from either of its congeners. Perhaps it comes nearest to *Teresa*. The toes are even broader proportionally; together much exceeding the width of the foot whence they issue. The eye is conspicuous, nearly frontal, but changes its position with the brain. The whole animal is colourless, but very full of folds and corrugations. Very long mucus-glands proceed from the toes through the whole of the foot.

The species first occurred to my observation on the 7th of May, 1887, on very fine seaweeds (*Ceramium*), which I gathered in the deep cup-like pool in limestone rock at Oddicombe Point. I met with about half-a-dozen examples. (Fig. 22.)

23. *Anurea schista*. Lorica oblong, tapering to a short spine behind; dorsal plate tessellated in polygonal areas on each side of a mesial ridge, and punctured; ventral plate much shorter, produced into a projecting sharp point, divided from the dorsal by a deep cleft. Length $1/162$ in., width $1/470$ in. Lacustrine.

It has relations with *stipitata* and *cochlearis*; in tessellation agreeing with the latter, and with *tecta*. The anterior spines are straight. It is evidently an approach to *Notholca*, but I do not see the ridges and furrows descending from the spines. The tessellæ are somewhat coarse and ill-defined. The straight short antlers, and the great descending point of the ventral plate, distinguish it at once from every known species. This point is a stiff taper spine: sometimes it projects obliquely (*b*); then, in a moment it is jerked in, so as to be quite hidden, only to be as rapidly thrown out again. Even in a dorsal view it can be clearly seen, through the transparent tissues. I believe I have seen, on two occasions, a discharged egg, carried under the belly, in the manner of *tecta*, &c. The eye is a ball of deep red, of enormous size. A very large contractile vesicle, when full, forces up the other viscera to the middle of the body; when, often, the well-defined contrast between the dark turbid contents of the intestine, and the crystal clearness of the bladder, is curious and striking. The bladder has no effect on the ventral spine, whose movements are manifestly voluntary. (Fig. 23.)

I have seen nearly a score of specimens in water sent by Mr. Bolton from the Botanic Garden, Birmingham. It is a sprightly active swimmer.

24. *Notholca labis*. Almost the very counterpart of *N. scapha*, save that the outline is a longer oval, and the lorica is prolonged into a short, broad, truncate tail behind. Length $1/216$ in.; width $1/370$ in. Lacustrine.

One of the discoveries of Mr. Hood of Dundee, who finds it numerous in a pool in Emmock Wood, near that city. He has repeatedly sent me specimens, but hitherto all have been dead on arrival. As, however, the internal organization is probably normal, the correctness of the diagnosis and delineation is not lessened by the fact that perfect loricae are at absolute command. The little tail to the lorica reminds one of the handle of a dust-pan, if so homely an illustration can be tolerated. The ridges and furrows from the frontal spines are almost obliterate. (Fig. 24.)

XIV.—*A Synopsis of the British Recent Foraminifera.*

By HENRY B. BRADY, F.R.S., F.G.S.

(Read 9th November, 1887.)

NEARLY thirty years have elapsed since the publication of Prof. W. C. Williamson's memoir on the 'Recent Foraminifera of Great Britain'—a work in which the scattered threads of earlier investigation were collected into an orderly skein, and interwoven with the results of a large amount of independent research. Whatever be its imperfections—and, considering the circumstances of the time, they are fewer and less important than might reasonably have been anticipated—that memoir represents fully and adequately the state of knowledge with respect to the organisms of which it treats up to the date of its publication, and practically marks the commencement of the recognition of the recent Foraminifera of the British Islands as a distinct branch of study.

The material to which Prof. Williamson had access consisted chiefly of shore-sands from various parts of the coast, together with a few dredgings obtained by the late Mr. Barlee and the late Mr. Jeffreys from the Shetland Seas, the western shores of Scotland, and one or two points on the south-west coast of England—all from comparatively shallow water. Of recent years, thanks partly to the periodical money-grants of the British Association, partly to the organization of local field-clubs, and most of all to the enthusiasm of amateur naturalists, the area of research has been vastly widened, and at the present time there are few promising portions of our coast that have not been explored more or less by means of the dredge; and our knowledge of every section of the marine invertebrate fauna has been correspondingly enriched.

So far as the Foraminifera are concerned, the additions to the British list have been so numerous as to be bewildering, notwithstanding the efforts that have been made from time to time by means of catalogues, printed privately or otherwise, to keep pace with the record of fresh occurrences. The latest catalogue of this sort, that drawn up by Mr. Siddall in 1879, though complete or approximately so when issued, even now requires an amount of revision that much diminishes its practical value. The recent dredging operations on the south-west of Ireland have added to our list a number of the deep-water species that venture within the limits assigned to the British area; and we seem to have arrived at a point from which we may profitably review our position. Whether the time has yet come for a fresh attempt to treat the subject fully and exhaustively, as was done by Prof. Williamson, may be open to question; but if so, the present paper can in no way prejudice such an effort—indeed it has been intended in some measure as a preliminary step in that direction, the aim having been to collect and sift existing material, and to draw attention to some of the numerous points concerning which our knowledge is defective.

The employment of modern dredging appliances, and the prosecution of researches in deeper water and further from land than was customary a few years ago, have opened a new question, namely,—what is to be understood by the term "British," as applied to the marine fauna and

flora? This subject was raised in the Biological Section of the British Association at the Birmingham meeting in 1886, and a Committee was appointed to consider it and report. The report, laid before the Manchester meeting (1887), which may be summarized as follows, will probably find general acceptance. It proposes to recognize a "British Marine Shallow-water District," and a "British Atlantic Slope District;" the former bounded to east and south by the half-way line between Great Britain and the continent of Europe, and to the west and north by the 100 fathom line, which corresponds roughly with the beginning of the declivity of the continental plateau; the latter, that is the "British Atlantic Slope District," extending from the 100 fathom line on the north and west coasts to say 1000 fathoms, that is to the commencement of the abyssal floor of the ocean.

These definitions are doubtless intended for general guidance rather than as the embodiment of fixed and absolute rules; and in the following Synopsis, which is otherwise limited to the "Shallow-water District," I have not felt at liberty to exclude the results of some of the recent dredgings on the south-west of Ireland at depths a little exceeding 100 fathoms; still less those of soundings from even deeper water in localities like Loch Fyne, which are geographically within the normal 100 fathom line.

The arrangement and nomenclature of the Synopsis are based upon the 'Report on the Foraminifera of the Challenger Expedition.' Reference is given to the original description of each species and, as far as possible, a further reference to the first record of its occurrence in a British locality, not, however, in the latter case going back further than Williamson's monograph. For synonyms, which have only been given in a few needful cases, the reader may be referred to the 'Challenger' Report.

I have had the advantage of the assistance of my friend Mr. W. Archer, F.R.S., of Dublin, with respect to the Gromidæ. The treatment of the Family, however, must be regarded as purely provisional. Those genera only have been included that are known to possess "reticulated" (as distinct from "lobose" or "filose") pseudopodia.

There are a certain number of species that, at one time or other, have found place in works on the British recent fauna, which are omitted in the present Synopsis. Of these the most important are *Peneroplis planatus* and *Vertebralina striata*, the specimens of which are now known to have been interlopers, due to the use of sieves previously employed for Mediterranean sands, and not properly cleaned; *Cristellaria strigilata* (*C. subarcuatula*, var. *costata*, Will.), *Frondicularia complanata* (*F. spatulata*, Will.), *Frondicularia archiaciana*, and *Nummulites radiata* (*N. planulata*, Will.), which are without doubt "derived" fossils from early Tertiary and Cretaceous strata. Possibly the broken specimen figured by Williamson (Plate ii., fig. 44), referred with reservation by some subsequent authors to *Nodosaria raphanistrum*, also pertains to the same category.

With respect to *Nummulites radiata*, I may say that the late Mr. Jeffreys was kind enough to give me a considerable number of the specimens dredged off Portsmouth, and their fossil condition appears to

admit of no question. I am informed by Prof. Williamson that the Scarborough specimen has been lost, but that it was of precisely similar character. A mounting from the Portsmouth gathering has been placed with the series of British Foraminifera in the British Museum.

There are a few other names that will not be found in their old places, partly owing to needful generic changes; of these the following are the more important:—

Biloculina contraria and *Hauerina compressa*—are now transferred to *Planispirina contraria*.

Reophax moniliforme, is referred to *R. findens*.

Textularia difformis—to *Bolivina difformis*.

Textularia pygmæa—to *Bolivina dilatata*.

Cassidulina pulchella and *Cassidulina oblonga*,—to *C. lævigata* and *C. crassa* respectively.

Lagena jeffreysii—to *L. hispida*.

Lagena lyellii—to *L. sulcata* and *L. costata*.

Nodosaria (Dent.) *guttifera*,—referred to *N. pyrula*.

Marginulina lituus—to *Cristellaria elongata*.

Polymorphina orbignii.—Fistulose specimens of *Polymorphina* are associated with the forms to which they respectively belong, and not treated collectively as a single species.

Discorbina obtusa—has been transferred to *D. wrightii*.

Discorbina ochracea—to *Trochammina ochracea*.

Pulvinulina sacculata.—The locality given by Messrs. Parker and Jones for this form—50 miles south-west of Ushant—is outside the British area.

Attention may be directed to certain species and varieties which have been retained in the list, but concerning which considerable uncertainty still exists; namely,—*Valvulina conica*, *Trochammina macrescens*, *Tr. plicata*, *Bathysiphon filiformis*, *Placopsilina bulla*, *P. varians*, *Reophax findens*, *Ramulina globulifera*, *Spirillina tuberculata*, *Nonionina boueana*, and *N. asterizans*. Further observations are still required on these, as well as on a few other forms that need not here be enumerated, to place our knowledge of their characters and distribution on a satisfactory footing.

I have now only to thank most cordially the naturalists who have aided me with notes and suggestions embodied in the following pages. I have already expressed the obligation I am under to Mr. Archer, and my acknowledgments are also due in an especial manner to Messrs. Joseph Wright, F.G.S., of Belfast, F. W. Millett, F.R.M.S., of Marazion, and David Robertson, F.G.S., of Millport, N.B., whose labours in connection with the British marine Rhizopoda are widely known, for much assistance, ever most kindly and freely rendered. To the friendly co-operation of these gentlemen any claim the present Synopsis may have to approximate completeness is largely due.

BIBLIOGRAPHY.

The following list embraces only such works on the British Recent Foraminifera as have been employed in the compilation of the present Synopsis, commencing with Prof. Williamson's Monograph in 1858; and is not in any way intended as a complete bibliography even of the limited field to which it refers.

1858. WILLIAMSON, W. C.—On the Recent Foraminifera of Great Britain. (Ray Society.)
1862. PARKER, W. K., and JONES, T. RUPERT.—Appendix to Carpenter's 'Introduction to the Study of the Foraminifera,' pp. 309-312.
1863. BRADY, HENRY B.—Notes on Foraminifera new to the British Fauna. (Report Brit. Assoc., Newcastle-upon-Tyne Meeting, Trans., pp. 100, 101.)
1864. ———— On the Rhizopodal Fauna of Shetland. (Trans. Linn. Soc. Lond., vol. xxiv. pp. 463-475, pl. xlviii.)
1865. ———— A Catalogue of the Recent Foraminifera of Northumberland and Durham. (Nat. Hist. Trans. Northd. and Durham, vol. i. pp. 83-107, pl. xii.)
1865. ALCOCK, Dr. T.—Notes on Natural History Specimens lately received from Connamara. (Proc. Lit. and Phil. Soc. Manchester, vol. iv. pp. 192-208.)
1866. BRADY, HENRY B.—On the Rhizopodal Fauna of the Hebrides. (Report Brit. Assoc., Nottingham Meeting, Trans., pp. 69, 70.)
1867. WALLER, EDWARD.—Report on the Foraminifera obtained in the Shetland Seas. (Report Brit. Assoc., Dundee Meeting, pp. 441-446.)
1870. BRADY, HENRY B.—On Brackish-water Foraminifera. (Ann. and Mag. Nat. Hist., Ser. 3, vol. vi. pp. 273-309, pl. xi., xii.)
1870. ———— Catalogue of British Foraminifera in the Edinburgh Museum of Science and Art.
1870. ARCHER, WILLIAM.—On some Freshwater Rhizopoda, new or little-known. (Quart. Journ. Micr. Sci., vol. x. N.S. pp. 101-124;—vol. ix. pl. xx.)
1870. CARTER, H. J.—On two New Species of the Foraminiferous Genus *Squamulina*, and on a New Species of *Difflugia*. (Ann. and Mag. Nat. Hist., Ser. 4, vol. v. pp. 309-326, pl. iv., v.)
1874. ROBERTSON, DAVID.—Notes on the Recent Foraminifera and Ostracoda of the Firth of Clyde. (Trans. Geol. Soc., Glasgow, vol. v. pp. 112-154.)
1875. ———— (G. S. Brady and Robertson), Report on Dredging off the Coast of Durham and North Yorkshire in 1874. (Report Brit. Assoc., Bristol Meeting, pp. 185-199.)
1877. ARCHER, WILLIAM.—Résumé of Recent Contributions to our Knowledge of Freshwater Rhizopoda. Part. IV. (Quart. Journ. Micr. Sci., vol. xvii. N.S., pp. 107-124, pl. viii.)
1877. WRIGHT, JOSEPH.—Recent Foraminifera of Down and Antrim. (Proc. Belfast Nat. Field Club, 1876-77, Appendix, pp. 101-105, pl. iv.)
1878. SIDDALL, J. D.—The Foraminifera of the River Dee. (Proc. Chester Soc. Nat. Science, pt. ii., pp. 42-56, woodcuts.)
1879. ———— Catalogue of British Recent Foraminifera, for the use of collectors, pp. 10.
1880. ———— On Shephardella, an Undescribed Type of Marine Rhizopoda, with a few Observations on Lieberkuehnia. (Quart. Journ. Micr. Sci., vol. xx. N.S. pp. 130-144, pl. xv., xvi.)
1880. ROBERTSON, DAVID.—Remarks on a few hauls with the Dredge in Portree Bay, Skye. (Proc. Nat. Hist. Soc. Glasgow, vol. v. pp. 11-13; also 1881-1883—further notes at pp. 17, 107, 163, 268 and 274 of the same volume).

1881. ARCHER, WILLIAM.—A New Sarcodine, possibly to be referred to the Genus *Microgromia*. (Ann. and Mag. Nat. Hist., ser. 5, vol. viii. pp. 230, 231.)
1881. WRIGHT, JOSEPH.—Foraminifera found during the Belfast Naturalists' Field Club's Excursion to South Donegal, 1880. (Proc. Belfast Nat. Field Club, 1880–81, Appendix, pp. 179–187, pl. viii.)
1884. BALKWILL, F. P., and MILLETT, F. W.—The Foraminifera of Galway. Journ. Microsc. and Nat. Sci., vol. iii. pp. 19–28; pp. 78–90, pl. i.–iv.)
1885. BALKWILL, F. P., and WRIGHT, JOS.—Report on some recent Foraminifera found off the Coast of Dublin and in the Irish Sea. (Trans. R. Irish Acad., vol. xxviii. [Science] pp. 317–372, pl. xii.–xiv.)
1885. MILLETT, F. W.—The Recent Foraminifera of Mount's Bay. (Trans. Penzance Nat. Hist. and Antiq. Soc., N.S. vol. ii. pp. 26–28.)
1886. WRIGHT, JOSEPH.—First Report on the Marine Fauna of the South-west of Ireland. (Proc. R. Irish Acad., ser. 2, vol. iv. [Science]—Foraminifera, pp. 607–614.)
1886. ———. Foraminifera of the Belfast Naturalists' Field Club's Cruise off Belfast Lough, in the Steam-tug 'Protector,' June, 1885; also Foraminifera found by Dr. Malcomson at Rockport, Belfast Lough. (Proc. Belfast Nat. Field Club, 1885–86, Appendix, pp. 317–325, pl. xxvi.)
1886. SIDDALL, J. D.—Report on the Foraminifera;—Liverpool Marine Biological Committee Report, No. 1. (Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, pp. 42–71, pl. i.)

SUB-KINGDOM—PROTOZOA.

CLASS—RHIZOPODA.

ORDER—Foraminifera (Reticularia).

Family I. GROMIDÆ.

LIEBERKUEHNIA, Claparède and Lachmann.*Lieberkuehnia wagneri*, Claparède and Lachmann.

- Lieberkuehnia wagneri*, Clap. and Lach., 1859, Mém. de l'Institut genevois, vol. vi. ;—1868, Études des Infusoires, pt. ii. p. 465, pl. xxiii.
- „ „ Siddall, 1879, Catal. Brit. Rec. Foram., p. 10;—1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl., Appendix, p. 48.

“Colwyn Bay, near Little Orme's Head, on Algæ and Hydrozoa. &c., from low water” (Siddall).

GROMIA, Dujardin.*Gromia oviformis*, Dujardin.

- Gromia oviformis*, Dujardin, 1835, Ann. Sci. Nat., sér. 2, vol. iii. p. 313;—vol. iv. p. 343, pl. ix. fig. 1.
- „ „ Siddall, 1879, Catal. Brit. Rec. Foram., p. 3;—1886, Proc. Lit. and Phil. Soc. Liverpool, vol. xl., Appendix, p. 49.
- “Muddy shores around the coast generally” (Siddall).

Gromia dujardinii, Schultze.

Gromia dujardinii, Schultze, 1854, Organ. Polythal., p. 55, pl. vii. figs. 1-7.

„ „ Siddall, 1879, Catal. Brit. Rec. Foram., p. 3;—
1886, Proc. Lit. and Phil. Soc. Liverpool, vol. xl, Appendix, p. 49.

“Muddy shores around the coast generally,” with the last-named species (Siddall).

MICROGROMIA, R. Hertwig.

Microgromia socialis, Archer.

Gromia socialis, Archer, 1870, Quart. Journ. Micr. Sci., vol. x. N.S. p. 124; vol. ix., pl. xx. figs. 7-11.

Microgromia socialis, Id. 1877, Ibid., vol. xvii. N.S. p. 115; pl. viii. fig. 8.

Glen-ma-lur Valley,—Co. Wicklow, and in some other subalpine districts in Ireland, rare (Archer).

Microgromia mucicola, Archer.

Microgromia mucicola, Archer, 1877, Quart. Journ. Micr. Sci., vol. xvii. N.S. p. 121, pl. viii. fig. 9.

“Nidulates in mucous envelope of certain unicellular Algæ” (Archer).

Microgromia ambigua, Archer.

Microgromia ambigua, Archer, 1881, Ann. and Mag. Nat. Hist., ser. 5, vol. viii. p. 230.

“Only probably belonging to this genus. Not rare in Midland pools, Ireland” (Archer).

DIAPHOROPODON, Archer.

Diaphoropodon mobile, Archer.

Diaphoropodon mobile, Archer, 1870, Quart. Journ. Micr. Sci., vol. x. N.S. p. 123; vol. ix. pl. xx. fig. 6.

Glen-ma-lur Valley,—Co. Wicklow, very rare (Archer).

SHEPHEARDELLA, Siddall.

Shepherdella tæniiformis, Siddall.

Shepherdella tæniiformis, Siddall, 1880, Quart. Journ. Micr. Sci., vol. xx. N.S. p. 130, pls. xv., xvi.

„ „ Id. 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl, Appendix, p. 49.

“On Hydrozoa dredged in Colwyn Bay. Frequent in spring at Tenby” (Siddall).

1887.

Family II. **MILIOLIDÆ.**Sub-family 1. **Nubecularinæ.****SQUAMULINA**, Schultze.*Squamulina lævis*, Schultze.

Squamulina lævis, Schultze, 1854, Organ. der Polythal., p. 56, pl. vi. figs. 16, 17.

„ „ Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl, Appendix, p. 50.

“Occurring on the polypidoms of zoophytes round the coast generally” (Siddall).

NUBECULARIA, Defrance.*Nubecularia lucifuga*, Defrance.

Nubecularia lucifuga, Defrance, 1825, Dict. Sci. Nat., vol. xxv. p. 120;—Atlas Zooph., pl. xlv. fig. 3.

„ „ Brady, 1879. Siddall's Catal. Brit. Rec. Foram., p. 10.

Cornwall coast, 60 fathoms; off Guernsey, dredged (Brady); Mouth of the Dee? (Siddall); Mount's Bay (Millett); Kilchattan Bay, Bute, 25 fathoms (Robertson).

Sub-family 2. **Miliolininæ.****BILOCULINA**, d'Orbigny.*Biloculina irregularis*, d'Orbigny.

Biloculina irregularis, d'Orbigny, 1839, Foram. Amér. Mérid., p. 67, pl. viii. figs. 20, 21.

Small specimens, apparently belonging to this form, occur in dredged sands from the Hebrides.

Biloculina sphæra, d'Orbigny.

Biloculina sphæra, d'Orbigny, 1839, Foram. Amér. Mérid., p. 66, pl. viii. figs. 13-16.

„ „ Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 466, pl. xlviii. fig. 1.

Shetland, Hebrides, dredged (Brady); south-west of Ireland, 79 to 200 fathoms (Wright).

Biloculina ringens, Lamarck, sp.

Miliolites ringens, Lamarck, 1804, Ann. du Muséum, vol. v. p. 351, No. 1;—vol. ix. pl. xvii. fig. 1.

Biloculina ringens, Williamson, 1858, Rec. For. Gt. Br., p. 79, pl. vi. figs. 169, 170.

Common all round the coast.

Biloculina depressa, d'Orbigny.

Biloculina depressa, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 298, No. 7;—Modèle, No. 91.

„ *ringens*, var. *carinata*, Williamson, 1858, Rec. For. Gt. Br., p. 79, pl. vii. figs. 172–174.

Common everywhere.

Biloculina elongata, d'Orbigny.

Biloculina elongata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 298, No. 4;—Soldani, Testac., vol. i. pt. 3, p. 228, pl. cliii. fig. M, Q; p. 231, pl. clvi. fig. *vv*.

„ *ringens*, var. *patagonica*, Williamson, 1858, Rec. For. Gt. Br., p. 80, pl. vii. figs. 175–6.

A common shallow-water form, hardly distinguishable varietyally from *B. ringens*.

SPIROLOCULINA, d'Orbigny.

Spiroloculina planulata, Lamarck, sp.

Miliolites planulata, Lamarck, 1805, Ann. du Muséum, vol. v. p. 352, No. 4;—1822, Anim. s. Vert., vol. vii. p. 613, No. 4.

Spiroloculina depressa, var. *rotundata*, Williamson, 1858, Rec. For. Gt. Br., p. 82, pl. vii. fig. 178.

A common shallow-water form.

Spiroloculina limbata, d'Orbigny.

Spiroloculina limbata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 299, No. 12;—Soldani, Testac., vol. ii. p. 54, pl. xix. fig. *m*.

„ *depressa*, Williamson, 1858, Rec. For. Gt. Br., p. 82, pl. vii. fig. 177.

Widely distributed.

Spiroloculina tenuiseptata, Brady.

Spiroloculina tenuiseptata, Brady, 1884, 'Challenger' Report, p. 153, pl. x. figs. 5, 6.

Common in Mr. Wright's dredgings from the south-west of Ireland.

Spiroloculina acutimargo, Brady.

Spiroloculina acutimargo, Brady, 1884, Challenger Report, p. 154, pl. x. figs. 12–15.

„ „ Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science), p. 323, wood-cut.

Lambay, 45 fathoms, specimens small and poor (Balkwill and Wright); Estuary of the Dee (Siddall).

Spiroloculina canaliculata, d'Orbigny.

Spiroloculina canaliculata, d'Orbigny, 1846, For. Foss. Vien., p. 269, pl. xvi. figs. 10–12.

Spiroloculina depressa, var. *cymbium*, Williamson, 1858, Rec. For. Gr. Br., p. 82, pl. vii. fig. 179.
Frequent.

Spiroloculina excavata, d'Orbigny.

Spiroloculina excavata, d'Orbigny, 1846, For. Foss. Vien., p. 271, pl. xvi. figs. 19–21.

„ „ Brady, 1865, Nat. Hist. Trans. Northd. and Durham, vol. i. p. 93, pl. xii. fig. 1.

Widely distributed, but less common than some other species of the genus.

MILIOLINA, Williamson.

Here, as in the 'Challenger' Report, I have retained the generic term *Miliolina* in the sense in which it is employed by Williamson. I do not, I hope, in the least underrate the value and importance of the researches of MM. Munier-Chalmas and Schlumberger on the embryology of the group, but I confess I am unable, in the present state of our knowledge, to see any way to the application of embryological characters to a practical and convenient system of generic nomenclature. So far as I understand, it is admitted that, whilst general rules may be laid down with relation to the embryological differences of certain subordinate groups, the "distinctive" features have a considerable range of variation, and are in fact not much more constant than those more easily recognized external peculiarities which serve as the basis of classification amongst other Foraminifera. We have, however, still much to learn in the matter, and everything to hope from M. Schlumberger's further investigations. Perhaps the difficulty may be eventually solved by the recognition of certain subgeneric types; the d'Orbignyan genus *Adelosina*, for example, represented in the British list by *Miliolina bicornis*, appears to be readily distinguishable, under ordinary circumstances, by external as well as internal characters.

Miliolina trigonula, Lamarck, sp.

Miliolites trigonula, Lamarck, 1804, Ann. du Muséum., vol. v. p. 351 No. 3;—1822, Anim. s. Vert., vol. vii. p. 612, No. 3.

Miliolina trigonula, Williamson, 1858, Rec. For. Gt. Br., p. 84, pl. vii. figs. 180–182.

Generally distributed.

Miliolina tricarinata, d'Orbigny, sp.

Triloculina tricarinata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 299, No. 7;—Modèle, No. 94.

„ „ Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 466, pl. xlviii. fig. 3.

Shetland (Brady, Waller); Estuary of the Dee (Siddall); Mount's Bay (Millett); various points on the coast of Ireland (Wright, Balkwill and Wright, Balkwill and Millett); west of Scotland (Robertson).

Miliolina insignis, Brady.

Miliolina insignis, Brady, 1884, Challenger Report, p. 165, pl. iv. figs. 8-10.

„ „ Wright, 1886, Proc. Belfast Nat. Field Club, 1885-6, Appendix, p. 319, pl. xxvi. fig. 4.

Belfast Lough, 60 fathoms (Wright).

Miliolina oblonga, Montagu, sp.

Vermiculium oblongum, Montagu, 1803, Test. Brit., p. 522, pl. xiv. fig. 9.

Miliolina seminulum, var. *oblonga*, Williamson, 1858, Rec. For. Gt. Br., p. 86, pl. vii. 186, 187.

Generally distributed.

Miliolina seminulum, Linné, sp.

Serpula seminulum, Linné, 1767, Syst. Nat., 12th ed., p. 1264, No. 791 ; —1788, 13th (Gmelin's) ed., p. 3739, No. 2.

Miliolina seminulum, Williamson, 1858, Rec. For. Gt. Br., p. 85, pl. vii. figs. 183-185.

Common on every part of the coast.

Miliolina venusta, Karrer, sp.

Quinqueloculina venusta, Karrer, 1868, Sitzungsab. d. k. Ak. Wiss. Wien, vol. lvii. p. 147, pl. ii. fig. 6.

Miliolina venusta, Robertson, 1882, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 268.

Loch Fyne (Robertson); Estuary of the Dee (Siddall).

Miliolina auberiana, d'Orbigny, sp.

Quinqueloculina auberiana, d'Orbigny, 1839, For. Cuba, p. 167, pl. xii. figs. 1-3.

Miliolina auberiana, Robertson, 1882, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 268.

Douglas Bay and Loch Fyne (Robertson); shore-sand, Galway (Balkwill and Millett); south-west of Ireland? (Wright).

Miliolina sclerotica, Karrer, sp.

Quinqueloculina sclerotica, Karrer, 1868, Sitz. d. k. Akad. Wiss. Wien, vol. lviii. p. 152, pl. iii. fig. 5.

Miliolina sclerotica, Balkwill and Millett, 1884, Journ. Micr. and Nat. Sci., vol. iii. p. 24, pl. 1, fig. 2.

Shore-sand, Galway (Balkwill and Millett); Mount's Bay (Millett); generally distributed round the Irish coast (Wright).

Miliolina contorta, d'Orbigny, sp.

Quinqueloculina contorta, d'Orbigny, 1846, For. Foss. Vien., p. 298, pl. xx. figs. 4-6.

Miliolina contorta, Robertson, 1882, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 268.

Loch Fyne (Robertson).

It appears probable that the specimens assigned provisionally by Messrs. Balkwill and Millett to *Miliolina sclerotica*, and those referred by Mr. Robertson to *Miliolina contorta*, belong in reality to the same species. Should that be the case the latter name would take precedence.

Miliolina labiosa, d'Orbigny, sp.

Triloculina labiosa, d'Orbigny, 1839, Foram. Cuba, p. 157, pl. x. figs. 12-14.

Miliolina labiosa, Robertson, 1882, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 268.

Loch Fyne (Robertson).

Miliolina subrotunda, Montagu, sp.

Vermiculum subrotundum, Montagu, 1803, Test. Brit., pt. 2, p. 521.

Quinqueloculina subrotunda, Brady, 1865, Nat. Hist. Trans. Northd. and Durham, vol. i. p. 94, pl. xii. fig. 2.

A very common littoral and shallow-water form.

Miliolina candeiana, d'Orbigny, sp.

Quinqueloculina candeiana, d'Orbigny, 1839, Foram. Cuba, p. 170, pl. xii. figs. 24-26.

„ „ Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 286, pl. xi. fig. 1.

Brackish water, River Cam (Brady); Estuary of the Dee (Siddall); Mount's Bay (Millett).

Miliolina secans, d'Orbigny, sp.

Quinqueloculina secans, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 303, No. 43;—Modèle, No. 96.

Miliolina seminulum, var. *disciformis*, Williamson, 1858, Rec. For. Gt. Br., p. 86, pl. vii. figs. 188, 189.

Generally distributed, but much less common than the last-named species.

Miliolina tenuis, Czjzek, sp.

Quinqueloculina tenuis, Czjzek, 1847, Haidinger's Naturw. Abhandl., vol. ii. p. 149, pl. xiii. figs. 31-34.

Miliolina tenuis, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 46.

Estuary of the Dee (Siddall); Irish Sea, not uncommon (Balkwill and Wright); Mount's Bay (Millett); south-west of Ireland (Wright); Portree, Skye (Robertson).

The characters of this, and in a less degree of the last-named species, are somewhat ambiguous, and there may be some doubt whether such forms are better placed amongst *Miliolinæ* or *Spiroloculinæ*.

Miliolina ferussacii, d'Orbigny, sp.

Quinqueloculina ferussacii, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 301, No. 18;—Modèle, No. 32.

Miliolina bicornis, var. *angulata*, Williamson, 1858, Rec. For. Gt. Br., p. 88, pl. vii. fig. 196.

By no means common, though widely distributed.

Miliolina bicornis, Walker and Jacob, sp.

Serpula bicornis, Walker and Jacob, 1798, Adams's Essays, Kanmacher's ed., p. 633, pl. xiv. fig. 2.

Miliolina bicornis, Williamson, 1858, Rec. For. Gt. Br., p. 87, pl. vii. figs. 190–192.

Not uncommon in shallow dredgings.

Miliolina boueana, d'Orbigny, sp.

Quinqueloculina boueana, d'Orbigny, 1846, For. Foss. Vien., p. 293, pl. xix. figs. 7–9.

Miliolina boueana, Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 51.

If it be needful to recognize by name the comparatively finely striate forms of *Miliolina* which have not retort-shaped segments, as distinct from those that have, *Quinqueloculina boueana* is perhaps the most convenient type to accept; better, I think, than *Triloculina brongniartiana*, d'Orb.

Of their distribution (apart from *M. bicornis*) we have little reliable information.

Miliolina pulchella, d'Orbigny, sp.

Quinqueloculina pulchella, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 303, No. 42;—Soldani, 1798, Testac., vol. ii. p. 53, pl. xviii. fig. f.

„ „ Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 466, pl. xlviii. fig. 4.

In dredgings at depths of thirty or forty fathoms or more at various points on the coast; somewhat rare.

Miliolina fusca, Brady.

Quinqueloculina fusca, Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 286, pl. xi. fig. 2.

Common in estuaries and brackish-water pools.

Miliolina agglutinans, d'Orbigny, sp.

Quinqueloculina agglutinans, d'Orbigny, 1839, Foram. Cuba, p. 168, pl. xii. figs. 11–13.

„ „ Brady, 1870, Edinburgh Catalogue, p. 2.

The first British specimens assigned to this species were subchitinous forms from brackish water, subsequently described under a distinct name,

Quinqueloculina fusca. Somewhat later, however, the typical *M. agglutinans* was found in dredgings from the Hebrides, and it has since been obtained on the Atlantic shores of Ireland by Mr. Wright, and in the Estuary of the Dee by Mr. Siddall.

Miliolina spiculifera, Siddall.

Miliolina spiculifera, Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 51, pl. i. fig. 3.

"A single example only from the Estuary of the Dee" (Siddall).

Sub-family 3. **Hauerininæ.**

OPHTHALMIDIUM, Kübler.

Ophthalmidium inconstans, Brady.

Hauerina inconstans, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 54.

Ophthalmidium inconstans, Id. 1884, Challenger Report, p. 189, pl. xii. figs. 5, 7, 8.

„ *carinatum*, Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science), p. 326, pl. xii. figs. 13-16.

The specimens figured by Messrs. Balkwill and Wright, under the name *O. carinatum*, do not appear to me to differ in any important particular from *O. inconstans*. It is true they are much smaller than even the small examples of the latter species obtained from oceanic dredgings, but this is sufficiently accounted for by depth and local conditions. Obtained also by Mr. Wright on the south-west of Ireland, 26 fathoms; and by Mr. Siddall in the Estuary of the Dee.

PLANISPIRINA, Seguenza.

Planispirina contraria, d'Orbigny, sp.

Biloculina contraria, d'Orbigny, 1846, For. Foss. Vien., p. 266, pl. xvi. figs. 4-6.

„ „ Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 466, pl. xlviii. fig. 2.

Very rare; occurs in dredgings off Shetland, 40 to 100 fathoms; and in Loch Scavaig, 45 to 60 fathoms (Brady); also on the south-west of Ireland (Brady, Wright).

Planispirina celata, Costa, sp.

Spiroloculina celata, Costa, 1855, Mem. Accad. Napoli, vol. ii. p. 126, pl. i. fig. 14;—1856, Atti dell' Accad. Pont., vol. vii. pl. xxvi. fig. 5.

Planispirina celata, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. p. 608.

Loch Scavaig, 45 to 60 fathoms (Brady); Portree Bay, Skye (Robertson); south-west of Ireland, 48 to 120 fathoms (Wright).

Sub-family 4. **Peneroplinidinae.**

CORNUSPIRA, Schultze.

Cornuspira foliacea, Philippi, sp.

Orbis foliaceus, Philippi, 1844, Enum. Moll. Sicil., vol. ii. p. 147, pl. xxiv. fig. 26.

Spirillina foliacea, Williamson, 1858, Rec. For. Gt. Brit., p. 91, pl. vii. figs. 199–201.

Generally distributed.

Cornuspira involvens, Reuss.

Operculina involvens, Reuss, 1849, Denkschr. d. k. Akad. Wiss. Wien, vol. i. p. 370, pl. xlv. fig. 20.

Cornuspira involvens, Siddall, 1876, Ann. and Mag. Nat. Hist., ser. 4, vol. xvii. p. 42.

Comparatively common; occurs in shallower water than its congener *C. foliacea*, preferring muddy bottoms.

Cornuspira carinata, Costa, sp.

Operculina carinata, Costa, 1856, Atti dell' Accad. Pont., vol. vii. p. 209, pl. xvii. fig. 15.

Cornuspira carinata, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. p. 608.

South-west of Ireland, 79 to 120 fathoms, rare (Wright).

Family III. **ASTRORHIZIDÆ.**

Sub-family 1. **Astrorhizinæ.**

ASTRORHIZA, Sandahl.

Astrorhiza limicola, Sandahl.

Astrorhiza limicola, Sandahl, 1857, Ofvers. af Kongl. Vetenskaps-Akad. Förhandl., vol. xiv. p. 299, pl. iii. figs. 5, 6.

„ „ Brady, 1879, in Siddall's Cat. Brit. Rec. For., p. 10.

At various points on the English and Scotch coast, at depths of 10 to 70 fathoms.

PELOSINA, Brady.

Pelosina variabilis, Brady.

Pelosina variabilis, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 30, pl. iii. figs. 1–3.

„ „ Robertson, 1881, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 163.

Cumbræ, Frith of Clyde (Robertson).

DENDROPHRYA, Str. Wright.

Dendrophrya radiata, Str. Wright.

Dendrophrya radiata, Wright, 1861, Ann. and Mag. Nat. Hist., ser. 3, vol. viii. p. 122.

Dendrophrya radiata, Brady, 1884, Challenger Report, p. 238, pl. xxvii A. figs. 10-12.

Old Granton Quarries, near Edinburgh (Str. Wright); low-tide pools, Cumbrae, Firth of Clyde (Robertson); "quite common along the N. Wales coast" (Siddall).

Dendrophrya erecta, Str. Wright.

Dendrophrya erecta, Wright, 1861, Ann. and Mag. Nat. Hist., ser. 3, vol. viii. p. 122, pl. iv. figs. 4, 5.

" " Brady, 1884, Challenger Report, p. 239, pl. xxvii A., figs. 7-9.

Distribution the same as that of the last-named species, from which, indeed, it seems scarcely separable.

Sub-family 2. Pilulininæ.

TECHNITELLA, Norman.

Technitella melo, Norman.

Technitella melo, Norman, 1878, Ann. and Mag. Nat. Hist., ser. 5, vol. i. p. 280, pl. xvi. figs. 5, 6.

" " Robertson, 1881, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 107.

Dredged off Oban (Robertson).

Technitella legumen, Norman.

Technitella legumen, Norman, 1878, Ann. and Mag. Nat. Hist., ser. 5, vol. i. p. 279, pl. xvi. figs. 3, 4.

" " Brady, 1884, Challenger Report, p. 246, pl. xxv. figs. 8-12.

Off Cumbrae, 60 to 65 fathoms; Loch Fyne, 160 fathoms (Robertson); off Isle of Man, 75 fathoms (Elcock); estuary of the Dee (Siddall); Irish Sea (Balkwill and Wright); south-west of Ireland, 112 fathoms (Norman).

BATHYSIPHON, Sars.

Bathysiphon filiformis, Sars.

Bathysiphon filiformis (M. Sars, MS.), G. O. Sars, 1871, Vidensk.-Selsk. Forhandl., 1871, p. 251.

" " Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. p. 608.

South-west of Ireland, 79 fathoms and 110 fathoms (Wright).

Careful examination of Mr. Wright's specimens leaves me in considerable doubt whether they belong to this species or indeed to this genus. They are exceedingly minute, and appear to be made of sponge spicules, but the test is relatively thinner and firmer than I should expect to find in the *Pilulininæ*.

Sub-family 3. **Saccammininæ.**

PSAMMOSPHERA, Schulze.

Psammosphæra fusca, Schulze.

Psammosphæra fusca, Schulze, 1874, II. Jahresberichte d. Komm. Unters. d. deutsch. Meere in Kiel, p. 113, pl. ii. fig. 8.

„ „ Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 27, pl. iv. figs. 1, 2.

Loch Scavaig, 45 to 60 fathoms (Brady); Portree Bay, Skye; off Cumbræ, 60 fathoms (Robertson); Lambay Deep (Balkwill and Wright); south-west of Ireland, 48 to 110 fathoms (Wright); doubtful specimens from the estuary of the Dee (Siddall).

Sub-family 4. **Rhabdammininæ.**

JACULELLA, Brady.

Jaculella acuta, Brady.

Jaculella acuta, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 35, pl. iii. figs. 12, 13.

„ „ Siddall, 1879, Cat. Brit. Rec. Foram., p. 4.

St. Magnus Bay, Shetland, 60 fathoms (Norman); off Cumbræ, 60 fathoms (Robertson); off Belfast Lough, 50 to 60 fathoms (Wright).

HYPERAMMINA, Brady.

Hyperammina elongata, Brady.

Hyperammina elongata (pars), Brady, 1878, Ann. and Mag. Nat. Hist., ser. 5, vol. i. p. 433, pl. xx. fig. 2.

„ „ Robertson, 1880-81, Proc. Nat. Hist. Soc. Glasgow, vol. v. pp. 12, 163.

Off Cumbræ, and off Portree Harbour, dredged (Robertson); estuary of the Dee, very rare (Siddall); Lambay, 45 to 50 fathoms, abundant; and at a few other places in the Irish Sea (Balkwill and Wright); between Belfast Lough and Portpatrick, 100 fathoms, and south-west of Ireland, 79 to 110 fathoms (Wright).

Hyperammina arborescens, Norman, sp.

Psammatotendron arborescens (Norman MS.), Brady, 1881, Denkschr. d. k. Akad. Wiss. Wien, vol. xliii. p. 98, No. 13;—Ann. and Mag. Nat. Hist., ser. 5, vol. viii. p. 404.

Hyperammina arbuscula, Robertson, 1881, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 163.

„ *arborescens*, Brady, 1884, Challenger Report, p. 262, pl. xxviii. figs. 12, 13, woodcut, fig. 10.

Dredged between Cumbræ and Bute, 50 fathoms; very common in the Frith of Clyde from 20 to 70 fathoms (Robertson); between Belfast Lough and Portpatrick, 30 to 60 fathoms (Wright).

HALIPHYSEMA, Bowerbank.

Haliphysema tumanowiczii, Bowerbank.

Haliphysema tumanowiczii, Bowerbank, 1862, Phil. Trans., p. 1105, pl. lxxiii. fig. 3.

Squamulina scopula, Carter, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. v. p. 310, pl. iv.

Off Hastings (Tumanowicz); Berwick Bay (Johnstone); Cullercoats? (Alder); Torbay (Parfitt); Budleigh Salterton (Carter); Mount's Bay (Millett); Colwyn Bay (Siddall); Dublin Bay (Haddon); Jersey (Kent).

Haliphysema ramulosum, Bowerbank.

Haliphysema ramulosa, Bowerbank, 1864–1866, Monogr. Brit. Spong., vol. ii. p. 79;—vol. iii. pl. xiii. fig. 1.

Squamulina scopula, "branched variety," Carter, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 345.

Budleigh Salterton, between tides (Carter); Roundstone Bay, Ireland, on seaweed in shallow water; Guernsey, 15 fathoms (Norman); Cumbrae, low-water, rare (Robertson).

Family IV. LITUOLIDÆ.

Sub-family 1. Lituolinæ.

REOPHAX, Montfort.

Reophax difflugiformis, Brady.

Reophax difflugiformis, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S., p. 51, pl. iv. fig. 3 *a b*.

" " Robertson, 1880, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 12.

Portree Bay, Skye, 14 to 18 fathoms (Robertson); Mount's Bay, Cornwall (Millett).

Reophax fusiformis, Williamson, sp.

Proteonina fusiformis, Williamson, 1858, Rec. For. Gt. Br., p. 1, pl. i. fig. 1.

Spread over a wide area, especially abundant on the west coast of Scotland.

Reophax scorpiurus, Montfort.

Reophax scorpiurus, Montfort, 1808, Conchyl. Systém., vol. i. p. 330, 83^e genre.

Lituola scorpiurus, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 467, pl. xlviii. fig. 5.

In dredged material from almost all parts of the coast.

Reophax nodulosa, Brady.

Reophax nodulosa, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 52, pl. iv. figs. 7, 8.

Reophax nodulosa, Robertson, 1880, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 12.

Frith of Clyde, and Portree Bay, Skye, 14 to 18 fathoms (Robertson); estuary of the Dee (Siddall).

Reophax findens, Parker, sp.

Lituola findens, Parker, 1870 (in Dawson's paper), Canad. Nat., vol. v. N.S. p. 177; p. 180, fig. 1.

„ „ Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 47.

Reophax moniliforme, Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 54, pl. i. fig. 2.

Estuary of the Dee (Siddall).

Considerable uncertainty appears to attend this somewhat anomalous species. Moniliform specimens, nearly always fragmentary, but as far as they go corresponding closely with Dr. G. M. Dawson's figures, are not uncommon in shallow dredgings from many parts of our coast. Some of these were supposed at first to be broken specimens of *Bigenerina digitata*, and were described as such by myself; but this explanation is now quite untenable. Mr. Wright's suggestion that they are portions of a sessile organism has much in its favour.

In places where *Reophax findens* abounds, as in Gaspé Bay, simple as well as branched examples are met with. Dr. Dawson, *loc. cit.*, gives three figures; the first of which represents a single moniliform series of segments, the second a specimen bifid for about half its length, whilst the third is trifid. So far as can be judged from Mr. Siddall's drawing there seem to be no characters by which his *Reophax moniliforme* can be distinguished from the first of these.

HAPLOPHRAGMIUM, REUSS.

Haplophragmium pseudospirale, Williamson, sp.

Protonina pseudospiralis, Williamson, 1858, Rec. For. Gt. Brit., p. 2, pl. i. figs. 2, 3.

Haplophragmium pseudospirale, Siddall, 1879, Cat. Brit. Rec. For., p. 4.

Common on the west coast of Scotland at 30 to 60 fathoms, also on the west and south-west of Ireland, 90 to 370 fathoms. Balkwill and Wright record its occurrence at Lambay, 45 to 50 fathoms, and at two points in the Irish Sea.

Haplophragmium agglutinans, d'Orbigny, sp.

Spirolina agglutinans, d'Orbigny, 1846, For. Foss. Vien., p. 137, pl. vii. figs. 10-12.

Haplophragmium agglutinans, Brady, 1884, Challenger Report, p. 301, pl. xxxii. figs. 19-26.

Isle of Wight, littoral (Millett); East Solent, 8 fathoms (Brady); Irish Sea, 17 fathoms and 50 fathoms (Balkwill and Wright).

Haplophragmium canariense, d'Orbigny, sp.

Nonionina canariensis, d'Orbigny, 1839, Foram. Canaries, p. 128, pl. ii. figs. 33, 34.

Nonionina jeffreysii, Williamson, 1858, Rec. For. Gt. Br., p. 34, pl. iii. figs. 72, 73.

Common on muddy bottom all round the coast.

Haplophragmium globigeriniforme, Parker and Jones, sp.

Lituola nautiloidea, var. *globigeriniformis*, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 407, pl. xv. figs. 46, 47, &c.

„ *globigeriniformis*, Wright, 1877, Proc. Belfast Nat. Field Club, 1876-77, Appendix, p. 103.

Various points on the Irish coast (Wright); Estuary of the Dee (Siddall).

Haplophragmium glomeratum, Brady.

Lituola glomerata, Brady, 1878, Ann. and Mag. Nat. Hist., ser. 5, vol. i. p. 433, pl. xx. fig. 1.

Haplophragmium glomeratum, Robertson, 1880, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 12.

This is probably not an uncommon form on muddy bottoms, but may be easily overlooked by reason of its minute size and inconspicuous characters. As a British species it was first noticed by Mr. Robertson in Portree Bay, Skye; subsequently by Mr. Wright in Killybegs Harbour, Donegal; and by Messrs. Balkwill and Wright at several points in the Irish Sea.

PLACOPSILINA, d'Orbigny.

Placopsilina cenomana, d'Orbigny.

Placopsilina cenomana, d'Orbigny, 1850, Prodr. Paléont., vol. ii. p. 185, No. 758.

„ „ Wright, 1886, Proc. Belfast Nat. Field Club, 1885-6, Appendix, p. 320, pl. xxvi. fig. 3.

Rockport, between tides (Malcomson); south-west of Ireland, 110 and 120 fathoms (Wright); Cumbrae, low-water (Robertson).

Placopsilina bulla, Brady.

Placopsilina bulla, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. N.S. p. 51.

„ „ Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 54.

Doubtful specimens from the estuary of the Dee (Siddall).

Placopsilina varians, Carter, sp.

Squamulina varians, Carter, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. v. p. 321, pl. v. figs. 1-5.

Placopsilina kingsleyi, Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 54, pl. i. fig. 1.

I am not prepared to say what is the precise position and relationship of this organism; but I believe Mr. Siddall's specimens to belong to the species described many years ago by Mr. Carter under the name *Squamulina varians*, and treated by him as a near ally of *Haliphysema*

tumanowiczii, with which it is often found associated. Mr. Carter's specimens were from Budleigh Salterton; Mr. Siddall's from the estuary of the Dee.

Sub-family 2. **Trochammininæ.**

THURAMMINA, Brady.

Thurammina papillata, Brady.

Thurammina papillata, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 45, pl. v. figs. 4-8.

„ „ Id. 1884, Challenger Report, p. 321, pl. xxxvi. figs. 7-18.

Loch Scavaig, 45 to 60 fathoms (Brady); south-west of Ireland, 38 to 110 fathoms (Wright).

AMMODISCUS, Reuss.

Ammodiscus incertus, d'Orbigny, sp.

Operculina incerta, d'Orbigny, 1839, Foram. Cuba, p. 71, pl. vi. figs. 16, 17.

Spirillina arenacea, Williamson, 1858, Rec. For. Gt. Br., p. 93, pl. vii. fig. 203.

Sparsely scattered all round the coast.

Ammodiscus gordialis, Jones and Parker, sp.

Trochammina squamata gordialis, Jones and Parker, 1860, Quart. Journ. Geol. Soc., vol. xvi. p. 304.

„ *gordialis*, Robertson, 1874, Trans. Geol. Soc. Glasgow, vol. v. pt. 1, p. 143.

Found with *A. incertus*, but comparatively rare.

Ammodiscus charoides, Jones and Parker, sp.

Trochammina squamata charoides, Jones and Parker, 1860, Quart. Journ. Geol. Soc., vol. xvi. p. 304.

„ *charoides*, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 47.

Estuary of the Dee (Siddall); Irish Sea (Balkwill and Wright); south-west of Ireland (Wright); Loch Fyne, 105 fathoms (Robertson).

Ammodiscus shoneanus, Siddall.

Trochammina shoneana, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 46, woodcuts 1, 2.

Estuary of the Dee (Siddall); Rockport, Belfast Lough (Malcomson); off Dublin (Wright); Cumbrae, and Loch Fyne (Robertson).

TROCHAMMINA, Parker and Jones.

Trochammina squamata, Jones and Parker.

Trochammina squamata, Jones and Parker, 1860, Quart. Journ. Geol. Soc., vol. xvi. p. 304.

Trochammina squamata, Brady, 1884, Challenger Report, p. 337, pl. xli. fig. 3.

Concerning the distribution of this form, as distinct from *Trochammina ochracea* on the one hand and *Valvulina fusca* on the other, we have but little reliable information.

Trochammina ochracea, Williamson, sp.

Rotalina ochracea, Williamson, 1858, Rec. For. Gt. Br., p. 55, pl. iv. fig. 112, pl. v. fig. 113.

Discorbina turbo, var. *ochracea*, Parker and Jones, 1862, Carpenter's Introd. Foram., Appendix, p. 311.

Shetland (Williamson); shore-sand Galway (Balkwill and Millett); Mount's Bay (Millett); generally distributed round the Irish coast, but the number of specimens small (Wright).

Trochammina plicata, Terquem, sp.

Patellina plicata, Terquem, 1876, Anim. sur la Plage de Dunkerque, 2^{me} fasc., p. 72, pl. viii. fig. 9.

Trochammina plicata, Balkwill and Millett, 1884, Journ. Microsc. and Nat. Sci., vol. iii. p. 26, pl. ii. fig. 8.

Shore-sand Galway (Balkwill and Millett); Mount's Bay, Cornwall (Millett).

Trochammina inflata, Montagu, sp.

Nautilus inflatus, Montagu, 1808, Test. Brit., Suppl., p. 81, pl. xviii. fig. 3.

Rotalina inflata, Williamson, 1858, Rec. For. Gt. Br., p. 50, pl. iv. figs. 93, 94.

Rarely met with except in brackish water.

Trochammina inflata, var. *macrescens*, Brady.

Trochammina inflata, var. *macrescens*, Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 290, pl. xi. fig. 5.

In brackish pools.

I have great doubt as to the propriety of retaining this form under a distinct name. The examination of a considerable series of specimens suggests that it represents only the depauperated condition of *Trochammina inflata*;—in other words, that when *Trochammina inflata* lives in pools, the water of which contains a very small proportion of mineral constituents, the test loses its firm shelly consistence and becomes little more than a chitinous envelope, so thin that the inflated contour of the segments is lost when the specimens are taken out of fluid and dried.

Trochammina nitida, Brady.

Trochammina nitida, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. N.S. p. 52; 1884, Challenger Report, p. 339, pl. xli. figs. 5, 6.

Trochammina nitida, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science), p. 609.

South-west of Ireland, 40 to 110 fathoms, rather rare (Wright); estuary of the Dee, rather rare (Siddall).

Trochammina trullissata, Brady.

Trochammina trullissata, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 56, pl. v. figs. 10, 11.

„ „ Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 609.

South-west of Ireland, 54 to 110 fathoms (Wright).

Trochammina robertsoni, n. sp.

Test free, planospiral, involute; discoidal, or compressed, nearly symmetrical bilaterally, more or less excavated at the umbilicus; peripheral edge rounded, lobulate; each convolution completely or almost completely enclosing that preceding it; segments somewhat inflated, usually five (four to six) in the outermost whorl: colour rich light brown, texture very finely arenaceous, surface polished. Diameter about $\frac{1}{100}$ th inch (0·25 millim.).

This prettily little *Trochammina* has long been familiar to those who have been in the habit of examining dredged material from the west coast of Scotland. I have before me drawings made nearly twenty years ago from Hebrides specimens, and it has since been repeatedly brought under my notice by the Rev. Dr. Norman and Mr. Robertson. It is very distinct from any of its congeners, and I have ventured to associate with it the name of my indefatigable friend who has done so much to elucidate the marine invertebrata of the Clyde region. The species is not uncommon in deepish water on the west of Scotland, and it occurs also in Mr. Wright's dredgings from the south-west of Ireland. I have placed a mounting of it, under its present name, in the British collection at the British Museum.

WEBBINA, d'Orbigny.

Webbina hemisphærica, Jones, Parker, and Brady.

Webbina hemisphærica, Jones, Parker, and Brady, 1866, Monogr. Crag Foram., p. 27, pl. iv. fig. 5.

„ „ Robertson, 1875, Report Brit. Ass., Bristol Meeting, p. 189.

Coast of Durham, 25 to 33 fathoms (Robertson).

Webbina clavata, Jones and Parker.

Trochammina irregularis clavata, Jones and Parker, 1860, Quart. Journ. Geol. Soc., vol. xvi. p. 304.

Webbina clavata, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science), p. 609.

South-west of Ireland, rare at 100 and 120 fathoms (Wright).
1887. 3 N

Family V. TEXTULARIDÆ.

Sub-family 1. Textularinæ.

TEXTULARIA, Defrance.

Textularia sagittula, Defrance.

Textularia sagittula, Defrance, 1824, Dict. Sci. Nat., vol. xxxii. p. 177 ;
vol. liii. p. 344 ;—Atlas Conch., pl. xiii. fig. 5.

„ *cuneiformis (typica)* ? Williamson, 1858, Rec. For. Gt. Br.,
p. 75, pl. vi. figs. 158, 159.

A common littoral and shallow-water form.

Textularia trochus, d'Orbigny.

Textularia trochus, d'Orbigny, 1840, Mem. Soc. Géol. France, vol. iv.
p. 45, pl. iv. figs. 25, 26.

„ *cuneiformis*, var. *conica*, Williamson, 1858, Rec. For. Gt.
Br., p. 75, pl. vi. figs. 160, 161.

Common.

Textularia agglutinans, d'Orbigny.

Textularia agglutinans, d'Orbigny, 1839, Foram. Cuba, p. 136, pl. i.
figs. 17, 18, 32–34.

„ „ Siddall, 1879, Catal. Brit. Rec. Foram., p. 8.

Generally distributed.

Textularia agglutinans, var. *porrecta*, Brady.

Textularia agglutinans, var. *porrecta*, Brady, 1884, Challenger Re-
port, p. 364, pl. liii. fig. 4.

„ „ „ Siddall, 1886, Proc. Lit. Phil.
Soc. Liverpool, vol. xl. Appendix, p. 65.

Mr. Siddall reports this variety from the estuary of the Dee.

Textularia gramen, d'Orbigny.

Textularia gramen, d'Orbigny, 1846, For. Foss. Vien., p. 248, pl. xv.
figs. 4–6.

„ „ Balkwill and Wright, 1885, Trans. R. Irish Acad.,
vol. xxviii. (Science) p. 332, pl. xiii. figs. 13, 14.

Frequent in the Irish Sea (Balkwill and Wright); and off south-west
of Ireland (Wright); shore-sand, Galway (Balkwill and Millett);
Mount's Bay, Cornwall (Millett).

Textularia concava, Karrer, sp.

Plecanium concavum, Karrer, 1868, Sitzungs b. d. k. Akad. Wiss. Wien,
vol. lviii. p. 129, pl. i. fig. 3.

Textularia concava, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv.
(Science) p. 609.

South-west of Ireland; 40 fathoms, downwards; abundant at 79
fathoms and 110 fathoms (Wright).

Textularia globulosa, Ehrenberg.

Textularia globulosa, Ehrenberg, 1839, Abhandl. Akad. Berlin (1838)
p. 135, No. 60, pl. iv. several figures.

„ „ Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4,
vol. vi. p. 300, pl. xii. fig. 4.

Westport, brackish water (Brady); off Dublin (Balkwill and Wright).

Textularia variabilis, Williamson.

Textularia variabilis (typica), Williamson, 1858, Rec. For. Gt. Brit.,
p. 76, pl. vi. figs. 162, 163.

Widely distributed.

Probably this, like many other of Williamson's *Textulariæ*, will
eventually be transferred to the genus *Bolivina*.

BIGENERINA, d'Orbigny.

Bigenerina digitata, d'Orbigny.

Bigenerina (Gemmulina) digitata, d'Orbigny, 1826, Ann. Sci. Nat.,
vol. vii. p. 262, No. 4;—Modèle, No. 58.

„ *digitata*, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv.
p. 468, pl. xlviii. fig. 8.

Shetland, Hebrides, estuary of the Dee, and at various points to the
west and south-west of Ireland.

Bigenerina nodosaria, d'Orbigny.

Bigenerina nodosaria, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 261,
No. 1, pl. xi, figs. 9–12;—Modèle, No. 57.

„ „ Waller, 1867, Report Brit. Assoc., Dundee
Meeting, p. 445.

Shetland (Waller, Brady); south-west of Ireland (Wright).

SPIROPLECTA, Ehrenberg.

Spiroplecta rosula, Ehrenberg.

Spiroplecta rosula, Ehrenberg, 1854, Mikrogeologie, pl. xxxii, II. fig. 26.

Textularia complexa, Brady, 1865, Nat. Hist. Trans. Northd. and
Durham, vol. i. p. 101, pl. xii. fig. 6.

Northumberland and Durham coast, very rare.

Spiroplecta biformis, Parker and Jones, sp.

Textularia agglutinans, var. *biformis*, Parker and Jones, 1865, Phil.
Trans., vol. clv. p. 370, pl. xv. figs. 23, 24.

Spiroplecta biformis, Balkwill and Wright, 1885, Trans. R. Irish Acad.,
vol. xxviii. (Science) p. 333, pl. xiii. fig. 21, and woodcut.

Belfast Lough (Malcomson); Dublin coast (Balkwill and Wright).

GAUDRYINA, d'Orbigny.

Gaudryina scabra, Brady.

Gaudryina pupoides, Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4,
vol. vi. p. 300, pl. xii. fig. 5.

Gaudryina scabra, Id., 1884, Challenger Report, p. 381, pl. xlv. fig. 7.

Montrose Basin, very rare.

It may here be mentioned that in Mr. Wright's cabinet there are small specimens of the typical *Gaudryina pupoides*, d'Orb., from 110, 160, and 200 fathoms respectively, on the south-west of Ireland.

Gaudryina filiformis, Berthelin.

Gaudryina filiformis, Berthelin, 1880, Mém. Soc. géol. France, sér. 3, vol. i. No. 5, p. 25, pl. i. fig. 8.

„ „ Wright, 1882, Proc. Belfast Nat. Field Club (1880-1), Appendix, p. 180, pl. viii. fig. 3, 3 a, b.

Killybegs Harbour, 17 fathoms, and south-west of Ireland (Wright); Dublin coast, rather rare (Balkwill and Wright); Galway (Balkwill and Millett); west of Scotland (Robertson); Mount's Bay, Cornwall (Millett).

VERNEUILINA, d'Orbigny.

Verneuilina polystropha, Reuss, sp.

Bulimina polystropha, Reuss, 1845, Verstein. Böhm. Kreid., pt. ii. p. 109, pl. xxiv. fig. 53.

„ *scabra*, Williamson, 1858, Rec. For. Gt. Brit., p. 65, pl. v. figs. 136, 137.

„ *arenacea*, Id., Ibid., p. 98.

Generally distributed.

Verneuilina spinulosa, Reuss.

Verneuilina spinulosa, Reuss, 1849, Denkschr. d. k. Ak. Wiss. Wien, vol. i. p. 374, pl. xlvii. fig. 12.

„ „ Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 301, pl. xii. fig. 6.

Westport, Ireland (Brady); Dublin coast (Balkwill and Wright); estuary of the Dee (Siddall).

VALVULINA, d'Orbigny.

Valvulina fusca, Williamson, sp.

Rotalina fusca, Williamson, 1858, Rec. For. Gt. Brit., p. 55, pl. v. figs. 114, 115.

Valvulina triangularis, var. *austriaca*, Parker and Jones, 1862, Carpenter's Introd. Foram., Appendix, p. 311.

Found on almost all parts of the coast.

Valvulina conica, Parker and Jones.

Valvulina triangularis, var. *conica*, Parker and Jones, 1865, Phil. Trans. vol. clv. p. 406, pl. xv. fig. 27.

„ *conica*, Brady, 1870, Edinburgh Catalogue, p. 3.

The only British specimens of this species I have seen were from Shetland and the Hebrides, and were doubtfully separable from *V. fusca*. Somewhat further north, and in deeper water, it is not very rare.

Sub-family 2. **Bulimininæ.**

BULIMINA, d'Orbigny.

Bulimina pupoides, d'Orbigny.

Bulimina pupoides, d'Orbigny, 1846, For. Foss. Vien., p. 185, pl. xi. figs. 11, 12.

„ „ Williamson, 1858, Rec. For. Gt. Brit., p. 62, pl. v. figs. 124, 125.

Bulimina ovata, d'Orbigny.

Bulimina ovata, d'Orbigny, 1846, For. Foss. Vien., p. 185, pl. xi. figs. 13, 14.

„ „ Brady, 1884, Challenger Report, p. 400, pl. 1. fig. 13.

As I have elsewhere stated (Challenger Report, p. 400), *Bulimina pupoides* and *B. ovata* (and it may be added *B. affinis*) “cannot be separated except by comparative characters too variable to be of any real zoological value.” I see no advantage in referring Williamson's *B. pupoides* var. *fusiformis* to *B. ovata*, as proposed by Parker and Jones; indeed it seems to be a fairly distinct form more nearly allied to *B. pupoides*. *B. ovata* stands about midway between *B. pupoides* and *B. pyrula*.

These *Buliminæ* are common all round the coast. Typical specimens of *B. ovata* are very abundant in some of Mr. Wright's material from the south-west of Ireland.

Bulimina fusiformis, Williamson.

Bulimina pupoides, var. *fusiformis*, Williamson, 1858, Rec. For. Gt. Br., p. 63, pl. v. figs. 129, 130.

„ *presli*, var. *ovata*, Parker and Jones, 1862, Carpenter's Introd. Forum., Appendix, p. 311.

Generally distributed.

Bulimina pyrula, d'Orbigny.

Bulimina pyrula, d'Orbigny, 1846, For. Foss. Vien., p. 184, pl. xi. figs. 9, 10.

South-west of Ireland; small specimens, fairly typical, at 40 fathoms, larger examples at 160 and 200 fathoms (Wright).

Bulimina marginata, d'Orbigny.

Bulimina marginata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 269, No. 4, pl. xii. figs. 10-12.

„ *pupoides*, var. *marginata*, Williamson, 1858, Rec. For. Gt. Br., p. 62, pl. v. figs. 126, 127.

Common.

Bulimina aculeata, d'Orbigny.

Bulimina aculeata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 269, No. 7;—Soldani, Testaceographia, vol. i. pt. 2, p. 118, pl. cxxvii. fig. I; pl. cxxx. fig. v v.

Bulimina pupoides, var. *spinulosa*, Williamson, 1858, Rec. For. Gt. Br., p. 62, pl. v. fig. 128.

Widely distributed but not so common as the last-named species, from which it is often with difficulty separable.

Bulimina convoluta, Williamson.

Bulimina pupoides, var. *convoluta*, Williamson, 1858, Rec. For. Gt. Br., p. 63, pl. v. figs. 132, 133.

Shetland, Skye (Williamson); an exceedingly rare form.

Bulimina subteres, Brady.

Bulimina prestli, var. *elegantissima*, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 374, pl. xv. figs. 12-17.

„ *subteres*, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. N.S. p. 55.

Shetland, west coast of Scotland, Irish Sea, north and west coasts of Ireland, and elsewhere.

Bulimina elegans, d'Orbigny.

Bulimina elegans, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 270, No. 10;—Modèle, No. 9.

„ „ Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 55.

Estuary of the Dee (Siddall); south-west of Ireland (Wright).

Bulimina elegantissima, d'Orbigny.

Bulimina elegantissima, d'Orbigny, 1839, Foram. Amér. Mérid., p. 51, pl. vii. figs. 13, 14.

„ „ Williamson, 1858, Rec. For. Gt. Brit., p. 64, pl. v. figs. 134, 135.

Sparsely distributed all round the coast.

Bulimina squamigera, d'Orbigny.

Bulimina squamigera, d'Orbigny, 1839, Foram. Canaries, p. 137, pl. i. figs. 22-24.

„ „ Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 49.

Estuary of the Dee (Siddall).

VIRGULINA, d'Orbigny.

Virgulina schreibersiana, Czjzek.

Virgulina schreibersiana, Czjzek, 1847, Haidinger's Naturw. Abhandl., vol. ii. p. 147, pl. xiii. figs. 18-21.

Bulimina pupoides, var. *compressa*, Williamson, 1858, Rec. For. Gt. Br., p. 63, pl. v. fig. 131.

Generally distributed.

BOLIVINA, d'Orbigny.

Bolivina punctata, d'Orbigny.

Bolivina punctata, d'Orbigny, 1839, Foram. Amér. Mérid., p. 63, pl. viii. figs. 10-12.

„ „ Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 468, pl. xlviii. fig. 9.

Generally distributed.

Bolivina plicata, d'Orbigny.

Bolivina plicata, d'Orbigny, 1839, Foram. Amér. Mérid., p. 62, pl. viii. figs. 4-7.

„ „ Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 302, pl. xii. fig. 7.

Found sparingly at a considerable number of localities, often in brackish water.

Bulimina buchiana, d'Orbigny.

Bulimina buchiana, d'Orbigny, 1846, For. Foss. Vien., p. 186, pl. xi. figs. 15-18.

„ „ Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 610.

South-west of Ireland, 48 to 120 fathoms (Wright).

Bolivina costata, d'Orbigny.

Bolivina costata, d'Orbigny, 1839, Foram. Amér. Mérid., p. 62, pl. viii. figs. 8, 9.

„ „ Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 302.

In shallow-water mud, Eastbourne, Sussex (Parker).

Bolivina difformis, Williamson, sp.

Textularia variabilis, var. *difformis*, Williamson, 1858, Rec. For. Gt. Br., p. 77, pl. vi. figs. 166, 167.

„ *agglutinans*, var. *difformis*, Parker and Jones, 1862, Carpenter's Introd. Foram., Appendix, p. 311.

Bolivina pygmæa, Brady, 1884, Challenger Report, p. 421, pl. liii. figs. 5, 6.

This is doubtless, as Messrs. Balkwill and Wright observe, a true *Bolivina*; and if so, the *Bolivina pygmæa* of the 'Challenger' Report may be merged into the same species.

It is a comparatively rare form on the British coast. Williamson gives no localities. It is, however, recorded from Shetland (Brady, Waller); estuary of the Dee (Siddall); Mount's Bay (Millett); Irish Sea (Balkwill and Wright); Galway (Balkwill and Millett); and the south-west of Ireland (Wright).

Bolivina dilatata, Reuss.

Bolivina dilatata, Reuss, 1849, Denkschr. d. k. Ak. Wiss. Wien, vol. i. p. 381, pl. xlviii. fig. 15.

Textularia variabilis, var. *spathulata*, Williamson, 1858, Rec. For. Gt. Br., p. 76, pl. vi. figs. 164, 165.

Bolivina dilatata, Robertson, 1880, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 12.

Torquay, Shetland (Williamson); Mount's Bay (Millett); Portree Bay, Skye (Robertson); Irish Sea, very rare (Balkwill and Wright); south-west of Ireland, common (Wright).

Bolivina lævigata, Williamson, sp.

Textularia variabilis, var. *lævigata*, Williamson, 1858, Rec. For. Gt. Br., p. 77, pl. vi. fig. 168.

Bolivina textularioides, Reuss, 1862, Sitzungs b. d. k. Akad. Wiss. Wien, vol. xlv. p. 81, pl. x. fig. i.

„ „ Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 334.

Off Dublin coast, rare (Balkwill and Wright); Mount's Bay (Millett); south-west of Ireland (Wright); shore-sand, Galway (Balkwill and Millett).

Messrs. Balkwill and Millett are probably correct in associating Williamson's *Textularia variabilis*, var. *lævigata* with Reuss's better known species. The change of name, however, entails a certain amount of inconvenience, as the term "*lævigata*" has been recently used by Karrer for a somewhat different modification of the type.

Bolivina ænariensis, Costa, sp.

Brizalina ænariensis, Costa, 1856, Atti dell' Accad. Pont., vol. vii. p. 297, pl. xv. fig. 1.

Bolivina costata, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 55.

„ *ænariensis*, Id., 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl.

Appendix, p. 56.

Estuary of the Dee (Siddall).

Sub-family 3. **Cassidulininæ.**

CASSIDULINA, d'Orbigny.

Cassidulina lævigata, d'Orbigny.

Cassidulina lævigata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 282, No. 1, pl. xv. figs. 4, 5;—Modèle, No. 41.

„ „ Williamson, 1858, Rec. For. Gt. Br., p. 68, pl. vi. figs. 141, 142.

Rare at depths of less than 30 fathoms or thereabouts, but comparatively common in deeper water off Shetland, the west of Scotland, and the west and south of Ireland.

No good purpose is served by attempting to separate *Cassidulina*

pulchella, d'Orbigny, from the typical *C. lævigata*; a few specimens with the sharp peripheral edge becoming slightly carinate are generally met with where the typical form abounds.

Cassidulina crassa, d'Orbigny.

Cassidulina crassa, d'Orbigny, 1839, Foram. Amér. Mérid., p. 56, pl. vii. figs. 18–20.

„ *obtusa*, Williamson, 1858, Rec. For. Gt. Br., p. 69, pl. vi. figs. 143, 144.

Distribution similar to that of *C. lævigata*, but it appears to frequent somewhat shallower water, and is not unfrequently found under such conditions where its congener is absent.

The *Cassidulina oblonga* of Reuss cannot be separated from this species.

Cassidulina bradyi, Norman.

Cassidulina bradyi (Norman MS.), Wright, 1880, Proc. Belfast Nat. Field Club (1879–80) Appendix, p. 152.

„ „ Brady, 1884, Challenger Report, p. 431, pl. liv. figs. 6–10.

South and west of Ireland, 54 to 120 fathoms (Norman, Wright, Brady).

Family VI. **CHILOSTOMELLIDÆ.**

CHILOSTOMELLA, Reuss.

Chilostomella ovoidea, Reuss.

Chilostomella ovoidea, Reuss, 1849, Denkschr. d. k. Akad. Wiss. Wien, vol. i. p. 380, pl. xlviii. fig. 12.

„ „ Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 66, pl. viii. figs. 11, 12.

Off Valentia, 112 fathoms (Norman); south-west of Ireland, 48 to 110 fathoms (Wright).

Family VII. **LAGENIDÆ.**

Sub-family 1. **Lageninæ.**

LAGENA, Walker and Boys.

Lagena globosa, Montagu, sp.

Vermiculum globosum, Montagu, 1803, Test. Brit., p. 523.

Entosolenia globosa, Williamson, 1858, Rec. For. Gt. Br., p. 8, pl. i. fig. 15, 16.

Common.

Lagena lævis, Montagu, sp.

Vermiculum læve, Montagu, 1803, Test. Brit., p. 524.

Lagena vulgaris, Williamson, 1858, Rec. For. Gt. Br., p. 4, pl. i. figs. 5, 5a.

Common.

Lagena clavata, d'Orbigny, sp.

Oolina clavata, d'Orbigny, 1846, For. Foss. Vien., p. 24, pl. i. figs. 2, 3.

Lagena vulgaris, var. *clavata*, Williamson, 1858, Rec. For. Gt. Br., p. 5, pl. i. fig. 6.

The fusiform, pointed variety of *L. lævis*, and probably equally common.

Lagena gracillima, Seguenza, sp.

Amphorina gracillima, Seguenza, 1862, Foram. Monot. Mess., p. 51, pl. i. fig. 37.

Lagena gracillima, Brady, 1870, Edinburgh Catalogue, p. 4.

Not unfrequent on muddy bottoms.

Lagena aspera, Reuss.

Lagena aspera, Reuss, 1861, Sitzungsab. d. k. Ak. Wiss. Wien, vol. xlv. p. 305, pl. i. fig. 5.

„ „ Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 48.

Estuary of the Dee (Siddall); Dublin coast and Irish Sea (Balkwill and Wright); Galway (Balkwill and Millett); Killybegs Harbour (Wright).

Lagena hispida, Reuss.

Lagena hispida, Reuss, 1858, Zeitschr. d. deutsch. geol. Gesell., vol. x. p. 434.

„ *jeffreysii*, Brady, 1866, Report Brit. Assoc., Nottingham Meeting,—Trans. p. 70.

West of Scotland, and various points on the coast of Ireland, rare; estuary of the Dee, rare.

Lagena jeffreysii appears to have no distinctive characters sufficiently constant to entitle it to separate treatment.

Lagena lineata, Williamson, sp.

Entosolenia globosa, var. *lineata*, Williamson, 1858, Rec. For. Gt. Br., p. 9, pl. i. fig. 17.

Lagena caudata, Parker and Jones, 1862, Carpenter's Introd. Foram., Appendix, p. 309.

Widely distributed.

Lagena distoma, Parker and Jones.

Lagena distoma, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 467, pl. xlviii. fig. 6.

Lagena sulcata, var. *distoma*, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 356, pl. xiii. fig. 20.

Found sparingly all round the coast.

Lagena curvilineata, Balkwill and Wright.

Lagena curvilineata, Balkwill and Wright, 1885, Trans. R. Irish. Acad., vol. xxviii. (Science) p. 338, pl. xiv. figs. 21–24.

Irish Sea (Balkwill and Wright); shore-sand, Galway (Balkwill and Millett); Loch Fyne (Robertson); Mount's Bay (Millett).

Lagena sulcata, Walker and Jacob, sp.

Serpula (*Lagena*) *sulcata*, Walker and Jacob, 1798, Adams's Essays, Kanmacher's ed., p. 634, pl. xiv. fig. 5.

Lagena vulgaris, var. *perlucida* (pars), Williamson, 1885, Rec. For. Gt. Br., p. 5, pl. i. fig. 8.

„ „ var. *striata*, Id. Ibid., p. 6. pl. i. fig. 10.

„ „ var. *interrupta*, Id. Ibid., p. 7, pl. i. fig. 11.

Common.

The apiculate forms of *Lagena sulcata* and *L. costata* constitute the *Amphorina lyellii* and *A. costata* of Seguenza; and it is probable, as suggested by the Rev. Dr. Norman, that portions of *Nodosaria scalaris*, var. *separans* have also been assigned to this group.

Lagena williamsoni, Alcock, sp.

Entosolenia williamsoni, Alcock, 1865, Proc. Lit. and Phil. Soc. Manchester, vol. iv. p. 195.

Lagena williamsoni, Wright, 1877, Proc. Belfast Nat. Field Club, 1876-77, Appendix, p. 104, pl. iv. fig. 14.

Common.

Lagena costata, Williamson, sp.

Entosolenia costata, Williamson, 1858, Rec. For. Gt. Br., p. 9, pl. i. fig. 18.

Lagena costata, Wright, 1877, Proc. Belfast Nat. Field Club, 1876-77, Appendix, p. 103, pl. iv. figs. 11-13.

Not uncommon in dredgings from moderate depths.

Lagena striata, d'Orbigny, sp.

Oolina striata, d'Orbigny, 1839, Foram. Amér. Mérid., p. 21, pl. v. fig. 12.

Lagena vulgaris, var. *substriata*, Williamson, 1858, Rec. For. Gt. Br., p. 7, pl. i. fig. 14.

Common.

Lagena gracilis, Williamson.

Lagena gracilis, Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 13, pl. i. fig. 5.

„ *vulgaris*, var. *gracilis*, Id. 1858, Rec. For. Gt. Br., p. 7, pl. i. figs. 12, 13.

Generally distributed, though scarcely so common as *L. striata*.

Lagena semistriata, Williamson.

Lagena striata, var. *semistriata*, Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 14, pl. i. figs. 9, 10.

„ *vulgaris*, var. *semistriata*, Id. 1858, Rec. For. Gt. Br., p. 6, pl. i. fig. 9.

Common.

Lagena striatopunctata, Parker and Jones.

Lagena sulcata, var. *striatopunctata*, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 350, pl. xiii. figs. 25-27.

„ *striatopunctata*, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 53.

Estuary of the Dee (Siddall); Irish Sea (Balkwill and Wright); Strangford Lough (Wright).

Lagena feildeniana, Brady.

Lagena feildeniana, Brady, 1878, Ann. and Mag. Nat. Hist., ser. 5, vol. i. p. 434, pl. xx. fig. 4.

„ „ Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 339, pl. xiv. fig. 19.

Irish Sea (Balkwill and Wright); estuary of the Dee (Siddall).

Lagena crenata, Parker and Jones.

Lagena crenata, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 420, pl. xviii. fig. 4.

„ „ Brady, 1866, Report Brit. Assoc., Nottingham Meeting, Trans., p. 70.

Dog's Bay, Connemara (Alcock); Hebrides (Brady); Shetland (Waller); Dublin Bay (Balkwill and Wright); south-west of Ireland (Wright).

Lagena squamosa, Montagu, sp.

Vermiculum squamosum, Montagu, 1803, Test. Brit., p. 526, pl. xiv. fig. 2.

Entosolenia squamosa Williamson, 1858, Rec. For. Gt. Br., p. 12, pl. i. fig. 29.

Common.

Lagena hexagona, Williamson, sp.

Entosolenia squamosa, var. *hexagona*, Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 20, pl. ii. fig. 23.

„ „ „ Id., 1858, Rec. For. Gt. Br., p. 13, pl. i. fig. 32.

„ „ var. *scalariformis*, Id., Ibid., p. 13, pl. i. fig. 30.

Common.

Lagena melo, d'Orbigny, sp.

Oolina melo, d'Orbigny, 1839, Foram. Amér. Mérid., p. 20, pl. v. fig. 9.

Entosolenia squamosa, var. *catenulata*, Williamson, 1858, Rec. For. Gt. Br., p. 13, pl. i. fig. 31.

Probably widely distributed, but characteristic specimens are certainly less common than the allied reticulate forms.

Lagena lævigata, Reuss, sp.

Fissurina lævigata, Reuss, 1849, Denkschr. d. k. Akad. Wiss. Wien, vol. i. p. 366, pl. xlv. fig. 1.

Lagena lævigata, Robertson, 1883, Trans. Geol. Soc. Glasgow, vol. vii. p. 24.

Common.

Trifacial specimens of this species have been named by Seguenza *Trigomulina oblonga*, by Siddall *Lagena trigono-oblonga*, and by Balkwill and Millett *Lagena trigono-lævigata*. Such examples are rare, but are occasionally met with when the typical form is plentiful.

Lagena faba, Balkwill and Millett.

Lagena faba, Balkwill and Millett, 1884, Journ. Micr. and Nat. Sci., vol. iii. p. 81, pl. ii. fig. 10.

Galway (Balkwill and Millett).

The authors above quoted describe trifacial specimens of the same variety under the name *Lagena trigono-faba*.

A very similar form to the *Fissurina aperta* of Seguenza, the latter being slightly carinate. I greatly doubt the wisdom of attempting to separate such specimens from *Lagena lævigata* and *L. marginata*.

Lagena marginata, Walker and Boys.

Serpula (Lagena) marginata, Walker and Boys, 1784, Test. Min., p. 2, pl. i. fig. 7.

Entosolenia marginata (pars), Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 17, pl. ii. figs. 15, 16.

„ „ (pars), Id., 1858, Rec. For. Gt. Br., p. 10, pl. i. fig. 21.

Common.

Trifacial specimens are described under the name *Trigomulina globosa* by Seguenza, and as *Lagena trigono-elliptica* by Balkwill and Millett. The mucronate form is the *Fissurina pedunculata* of Seguenza, and the *Lagena marginata*, var. *pedunculata* of Balkwill and Millett.

Lagena lucida, Williamson, sp.

Entosolenia marginata, var. *lucida*, Williamson, 1858, Rec. For. Gt. Br., p. 10, pl. i. figs. 22, 23.

Not uncommon.

A variety of *L. lævigata*, broadest near the base. Apiculate specimens of the same form constitute the *Fissurina acuta* of Reuss.

Lagena quadrata, Williamson, sp.

Entosolenia marginata, var. *quadrata*, Williamson, 1858, Rec. For. Gt. Br., p. 11, pl. i. figs. 27, 28.

Scarcely separable in point of distribution from the other varieties of *L. marginata*.

Partially carinate specimens are named *Lagena quadrata*, var. *semialata* by Messrs. Balkwill and Millett.

Lagena bicarinata, Terquem, sp.

Fissurina bicarinata, Terquem, 1882, Mém. Soc. géol. France, sér. 3, vol. ii. Mém. III. p. 31, pl. i. fig. 24.

Lagena bicarinata, Balkwill and Millett, 1884, Journ. Microsc. and Nat. Sci., vol. iii. p. 82, pl. iii. fig. 9.

Shore-sand, Galway (Balkwill and Millett); Irish Sea (Balkwill and Wright); south-west of Ireland (Wright);—very rare.

Trifacial specimens constitute the *Lagena trigono-bicarinata* of Messrs. Balkwill and Millett's memoir.

Lagena orbignyana, Seguenza, sp.

Fissurina orbignyana, Seguenza, 1862, Foram. Monot. Mess., p. 66, pl. ii. figs. 25, 26.

Entosolenia marginata (pars), Williamson, 1858, Rec. For. Gt. Br., p. 9, pl. i. figs. 19, 20.

Common.

The trifacial form is named *Lagena trigono-marginata* by Parker and Jones, and *Lagena trigono-orbignyana* by Balkwill and Millett; and quadrifacial specimens *Lagena quadrigono-orbignyana* by the latter authors.

Lagena castrensis, Schwager.

Lagena castrensis, Schwager, 1866, Novara-Exped., geol. Theil, vol. ii. p. 208, pl. v. fig. 22.

„ „ Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 341, pl. xii. figs. 20, 21.

Off Lambay, 45 to 50 fathoms, very rare (Balkwill and Wright).

Lagena clathrata, Brady.

Lagena clathrata, Brady, 1884, Challenger Report, p. 485, pl. lx. fig. 4.

„ „ Balkwill and Millett, 1884, Journ. Microsc. and Nat. Sci., vol. iii. p. 82, pl. ii. fig. 14.

Shore-sand, Galway (Balkwill and Millett).

The same authors record quadrifacial specimens under the name of *Lagena quadrigono-clathrata*.

Lagena pulchella, Brady.

Lagena pulchella, Brady, 1866, Report Brit. Assoc., Nottingham Meeting, Trans., p. 70.

„ „ Id., 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 294, pl. 12, fig. 1.

Granton Harbour, Fintry Bay, Cumbræ (Brady); Oban (Robertson); shore-sand, Galway (Balkwill and Millett); Dublin coast (Balkwill and Wright).

Messrs. Balkwill and Millett have also trifacial specimens which they name *Lagena trigono-pulchella*.

Lagena lagenoides, Williamson, sp.

Entosolenia marginata, var. *lagenoides*, Williamson, 1858, Rec. For. Gt. Br., p. 11, pl. i. figs. 25, 26.

Sparsely distributed all round the coast.

Messrs. Balkwill and Wright regard the form which I have named *Lagena trigono-ornata* (Challenger Report, p. 483, pl. lxi. fig. 14), as the trifacial modification of this species. To me the 'Challenger' specimens appear to be in closer relationship with *Lagena ornata*, Will.; it is probable, however, that both varieties (if they are separable) are represented in the trifacial series.

Lagena lagenoides, var. *tenuistriata*, Brady.

Lagena tubulifera, var. *tenuistriata*, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. N.S. p. 61.

„ *lagenoides*, var. *tenuistriata*, Id., 1884, Challenger Report, p. 479, pl. lx. figs. 11, 15, 16.

„ „ „ Balkwill and Millett, 1884, Journ. Microsc. and Nat. Sci., vol. iii. p. 82, pl. ii. fig. 12.

Shore-sand, Galway (Balkwill and Millett); occasionally met with round the Irish coast (Wright).

From the same locality the last-named authors obtained trifacial specimens which they call *Lagena trigono-tenuistriata*.

Lagena ornata, Williamson, sp.

Entosolenia marginata, var. *ornata*, Williamson, 1858, Rec. For. Gt. Br., p. 11, pl. i. fig. 24.

Whitehaven; Shetland (Williamson). This form has been so much associated with *L. lagenoides*, that it is difficult to lay down the distribution of either as distinct from the other.

Lagena fimbriata, Brady.

Lagena fimbriata, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. N.S. p. 61.

„ „ Balkwill and Millett, 1884, Journ. Microsc. and Nat. Sci., vol. iii. p. 82, pl. ii. fig. 5.

Shore-sand, Galway (Balkwill and Millett); south-west of Ireland, 40 to 110 fathoms (Wright).

Sub-family 2. Nodosarinae.

NODOSARIA, Lamarck.

Nodosaria lævigata, d'Orbigny.

Nodosaria (*Glandulina*) *lævigata*, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 252, No. 1, pl. x. figs. 1-3.

Glandulina lævigata, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 468, pl. xlviii. fig. 7.

Shetland (Waller, Brady); Cumbræ (Robertson); south-west of Ireland (Wright).

Nodosaria rotundata, Reuss, sp.

Glandulina rotundata, Reuss, 1849, Denkschr. d. k. Akad. Wiss. Wien, vol. i. p. 366, pl. xlv. fig. 2.

Nodosaria (Glandulina) rotundata, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 612.
South-west of Ireland, 79 to 120 fathoms (Wright).

Nodosaria radícula, Linné, sp.

Nautilus radícula, Linné, 1767, Syst. Nat., 12th ed., p. 1164, 285;—
1788, Ibid. 13th (Gmelin's) ed., vol. i. pt. 6, p. 3373, No. 18.
Nodosaria radícula, Brady, 1870, Edinburgh Catalogue, p. 8.

West of Scotland (Brady); estuary of the Dee (Siddall); off the Isle of Man (Balkwill and Wright); south-west of Ireland (Wright); in all localities very rare.

Nodosaria pyrula, d'Orbigny.

Nodosaria pyrula, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 253, No. 13;—Soldani, Testac., vol. ii. p. 35, pl. x. figs. b, c.

„ „ Williamson, 1858, Rec. For. Gt. Br., p. 17, pl. ii. fig. 39.

Dentalina guttifera, Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 296, pl. xii. fig. 2.

Found sparingly in dredged sands from almost every part of the coast.

Curved specimens of this form have been recorded under the name of *Dentalina guttifera*.

Nodosaria consobrina, d'Orbigny, sp.

Dentalina consobrina, d'Orbigny, 1846, For. Foss. Vien., p. 46, pl. ii. figs. 1–3.

„ „ Robertson, 1875, Report Brit. Assoc., Bristol Meeting, p. 190.

Durham coast (Robertson); Irish Sea (Balkwill and Wright); south-west of Ireland (Wright).

Nodosaria humilis, Roemer.

Nodosaria humilis, Roemer, 1841, Verstein. Norddeutsch. Kreid., pt. ii. p. 95, pl. xv. fig. 6.

„ „ Siddall, 1879, Cat. Brit. Rec. For., p. 6.
Shetland (Brady).

Perhaps a needless species, the specimens of which might be assigned either to *N. radícula* or to *N. (Gl.) æqualis*.

Nodosaria communis, d'Orbigny.

Nodosaria (Dentalina) communis, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 254, No. 35.

Dentalina subarcuata, Williamson, 1858, Rec. For. Gt. Br., p. 18, pl. ii. figs. 40, 41.

Generally distributed.

Short stout specimens, with few chambers, have sometimes been separately treated under the name *Dentalina brevis*.

Nodosaria pauperata, d'Orbigny, sp.

Dentalina pauperata, d'Orbigny, 1846, For. Foss. Vien., p. 46, pl. i. figs. 57, 58.

„ „ Robertson, 1875, Report Brit. Assoc., Bristol Meeting, p. 190.

Found occasionally with the allied unornamented varieties.

Nodosaria hispida, d'Orbigny.

Nodosaria hispida, d'Orbigny, 1846, For. Foss. Vien., p. 35, pl. i. figs. 24, 25.

„ „ Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science), p. 343, pl. xii. fig. 31.

Irish Sea, off the Isle of Man (Elcock, Balkwill and Wright); estuary of the Dee (Siddall).

Nodosaria scalaris, Batsch, sp.

Nautilus (Orthoceras) scalaris, Batsch, 1791, Conchyl. des Seesandes, No. 4, pl. ii. fig. 4.

Nodosaria radícula, Williamson, 1858, Rec. For. Gt. Br., p. 15, pl. ii. figs. 36-38.

Generally distributed. Mr. Wright reports specimens of *N. scalaris*, var. *separans*, from south-west of Ireland, 40 to 200 fathoms.

Nodosaria raphanus, Linné, sp.

Nautilus raphanus, Linné, 1767, Syst. Nat., 12th ed., p. 1164, 283;— 1788, Ibid., 13th (Gmelin's) ed., p. 3372, No. 16.

Dentalina subarcuata, var. *jugosa* (pars), Williamson, 1858, Rec. For. Gt. Br., p. 20, pl. ii. fig. 43.

Shetland (Brady); south-west of Ireland, 100 to 200 fathoms (Wright).

Nodosaria raphanistrum, Linné, sp., has been sometimes admitted to the list of British recent species on the evidence of one of the figures in Prof. Williamson's work (Pl. ii. fig. 44). The drawing in question is from a broken specimen, and is associated by the author with two others, which are now regarded as representing *Nodosaria obliqua* and *N. raphanus* respectively. The habitat is not given, and it appears even possible that the specimen, like some other *Nodosarinæ* on the same plate, may be a derived fossil. Whilst there is this uncertainty it is evident that *N. raphanistrum* is better omitted from our list.

Nodosaria obliqua, Linné, sp.

Nautilus obliquus, Linné, 1767, Syst. Nat., 12th ed., p. 1163, 281;— 1788, Ibid., 13th (Gmelin's) ed., p. 3372, No. 14.

Dentalina subarcuata, var. *jugosa* (pars), Williamson, 1858, Rec. For. Gt. Br., p. 20, pl. ii. fig. 42.

„ *obliquestriata*, Robertson, 1875, Report Brit. Assoc., Bristol Meeting, p. 190.

Widely distributed, but the number of specimens generally small. 1887.

Specimens with oblique costæ cannot be separated specifically from the straight-ribbed forms; every shade of variation in this particular is to be met with.

Dentalina obliqua, "d'Orbigny," is noticeable in several British lists, a perpetuation probably of an error of my own, the present form being intended. D'Orbigny's "*obliqua*" is now known under Neugeboren's name *Nodosaria (Dentalina) mucronata*, and there is no certain evidence of the occurrence of this variety on our shores.

LINGULINA, d'Orbigny.

Lingulina carinata, d'Orbigny.

Lingulina carinata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 257, No. 1;—Modèle, No. 26.

„ „ Williamson, 1858, Rec. For. Gt. Br., p. 14, pl. ii. figs. 33–35.

Shetland, Skye, Plymouth Sound (Williamson); Irish Sea (Balkwill and Wright); shore-sand, Galway (Balkwill and Millett); Killybegs Harbour (Wright).

VAGINULINA, d'Orbigny.

Vaginulina legumen, Linné, sp.

Nautilus legumen, Linné, 1758, Syst. Nat., 10th ed., p. 711, No. 248;—1767, Ibid., 12th ed., p. 1164, No. 288.

Dentalina legumen, Williamson, 1858, Rec. For. Gt. Br., p. 21, pl. ii. fig. 45.

Widely distributed.

Vaginulina linearis, Montagu, sp.

Nautilus linearis, Montagu, 1808, Test. Brit., Suppl., p. 87, pl. xxx. fig. 9.

Dentalina legumen, var. *linearis*, Williamson, 1858, Rec. For. Gt. Br., p. 23, pl. ii. figs. 46–48.

Widely distributed.

RHABDOGONIUM, Reuss.

Rhabdogonium tricarinatum, d'Orbigny, sp.

Vaginulina tricarinata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 258, No. 4;—Modèle, No. 4.

Rhabdogonium tricarinatum, Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 344, pl. xii. figs. 17, 18.

Lambay? (Balkwill and Wright); south-west of Ireland, 100 to 200 fathoms (Wright).

MARGINULINA, d'Orbigny.

Marginulina glabra, d'Orbigny.

Marginulina glabra, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 259, No. 6;—Modèle, No. 55.

Marginulina glabra, Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 296, pl. xii. fig. 3.

Occasional specimens at many points both of the British and Irish coast.

Marginulina costata, Batsch, sp.

Nautilus (*Orthoceras*) *costatus*, Batsch, 1791, Conchyl. des Seesandes, p. 2, pl. 1, fig. 1.

Marginulina raphanus, Brady, 1866, Report Brit. Assoc., Nottingham Meeting, Trans., p. 70.

Hebrides (Brady); estuary of the Dee (Siddall); Irish Sea (Balkwill and Wright); south-west of Ireland (Wright); specimens rare and except in the last-named locality usually small.

CRISTELLARIA, Lamarek.

Cristellaria elongata, Williamson.

Cristellaria subarcuatula, var. *elongata*, Williamson, 1858, Rec. For. Gt. Br., p. 30, pl. ii. fig. 62.

Marginulina lituus, Parker and Jones, 1862, Carpenter's Introd. Foram., Appendix, p. 310.

Killybegs Harbour (Wright). Williamson gives no locality for his specimen.

In so far as the generic distinction is of any value, Williamson's figure is that of a *Cristellaria*, not a *Marginulina*. It differs little, if at all, from the *Cristellaria obtusata* of Reuss.

Cristellaria crepidula, Fichtel and Moll, sp.

Nautilus crepidula, Fichtel and Moll, 1803, Test. Micr., p. 107, pl. xix. figs. *g-i*.

Cristellaria subarcuatula, Williamson, 1858, Rec. For. Gt. Br., p. 29, pl. ii. figs. 56, 57.

Widely distributed.

Cristellaria rotulata, Lamarek, sp.

Lenticulites rotulata, Lamarek, 1804, Ann. du Muséum, vol. v. p. 188, No. 3;—Tableau Encycl. et Méth., pl. cccclxvi. fig. 5.

Cristellaria calcar (*typica*), Williamson, 1858, Rec. For. Gt. Br., p. 27, pl. ii. figs. 52, 53.

Widely distributed.

Cristellaria cultrata, Montfort, sp.

Robulus cultratus, Montfort, 1808, Conchyl. Systém., vol. i. p. 214, 54^e genre.

Cristellaria cultrata, Brady, 1866, Report Brit. Assoc., Nottingham Meeting, Trans., p. 70.

Carinate *Cristellariæ* are rare in the British seas. Occasional specimens are found associated with *C. rotulata*, but they are invariably small and the peripheral keel only slightly developed.

Cristellaria vortex, Fichtel and Moll, sp.

Nautilus vortex, Fichtel and Moll, 1803, Test. Micr., p. 33, pl. ii. figs. d-i.

Cristellaria vortex, Brady, 1870, Edinburgh Catalogue, p. 8.

Small starved specimens, doubtfully referrible to this species, from the west coast of Scotland.

Cristellaria variabilis, Reuss.

Cristellaria variabilis, Reuss, 1849, Denkschr. d. k. Akad. Wiss. Wien, vol. i. p. 369, pl. xlv. figs. 15, 16.

„ „ Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 612.

South-west of Ireland, 100 to 200 fathoms, rare (Wright).

Cristellaria italica, Defrance, sp.

Saracenaria italica, Defrance, 1824, Dict. Sci. Nat., vol. xxxii. p. 177;—vol. xlvii. p. 344;—Atlas Conch., pl. xiii. fig. 6.

Cristellaria subarcuatula, var. *scapha*, Williamson, 1858, Rec. For. Gt. Br., p. 30, pl. ii. figs. 60, 61.

Estuary of the Dee, rare (Siddall). Williamson gives no locality for the broken specimen figured in his work.

AMPHICORYNE, Schlumberger.

Amphicoryne falx, Jones and Parker, sp.

Marginulina falx, Jones and Parker, 1860, Quart. Journ. Geol. Soc., vol. xvi. p. 302, No. 28.

South-west of Ireland, 79 to 400 fathoms, rare (Wright).

Sub-family 3. Polymorphininae.

POLYMORPHINA, d'Orbigny.

Polymorphina lactea, Walker and Jacob, sp.

Serpula lactea, Walker and Jacob, 1798, Adams's Essays, Kanmacher's ed., p. 634, pl. xiv. fig. 4.

Polymorphina lactea (*typica*), pars, Williamson, 1858, Rec. For. Gt. Br., p. 70, pl. vi. fig. 147.

„ „ var. *communis*, Id., Ibid., p. 72, pl. vi. figs. 153-155.

Generally distributed.

Polymorphina gibba, d'Orbigny.

Polymorphina (*Globulina*) *gibba*, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 266, No. 20;—Modèle, No. 63.

„ *gibba*, Brady, 1870, Edinburgh Catalogue, p. 5.

Scarcely separable either in characters or distribution from the foregoing species. Futile attempts have been made (by myself amongst others) to distinguish the more or less compressed specimens both of

P. lactea and *P. gibba* by varietal names—*P. lactea*, var. *amygdaloides*, Reuss, and *P. gibba*, var. *æqualis*, d'Orbigny—respectively; but the distinction has not been found to possess the least zoological value.

Polymorphina problema, d'Orbigny.

Polymorphina (Guttulina) problema, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 266, No. 14;—Modèle, No. 61.

„ „ *communis*, Id., Ibid., p. 266, No. 15, pl. xii. figs. 1-4;—Modèle, No. 62.

„ *communis*, Brady, 1870, Edinburgh Catalogue, p. 5.

Widely distributed.

It is quite impossible to separate *Polymorphina communis* from *P. problema*, and as d'Orbigny's model of the latter form presents the best developed characters, I have followed Reuss in accepting it as the type.

Polymorphina lactea, var. *oblonga*, Williamson.

Polymorphina lactea, var. *oblonga*, Williamson, 1858, Rec. For. Gt. Br., p. 71, pl. vi. figs. 149, 149a.

Widely distributed.

I have for the moment retained the trivial name "*oblonga*" just as given by Williamson, that is to say varietally. The same term had been used twice previously in connection with the genus, namely by Roemer (Neues Jahrb. für Min., &c., 1838, p. 386, pl. iii. fig. 34) and by d'Orbigny (For. Foss. Vien., p. 232, pl. xii. figs. 29-31). Roemer's specimens, so far as can be judged from his figure, may be disposed of by referring them to *P. communis* or *P. problema*; and those from the Vienna Basin might be fitly assigned to the earlier d'Orbignyan species *P. soldanii* (Ann. Sci. Nat., vol. vii. p. 265, No. 12). If this course be adopted Williamson's form, which has tolerably distinctive characters, will stand as *Polymorphina oblonga*.

Polymorphina thouini, d'Orbigny.

Polymorphina thouini, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 265, No. 8;—Modèle, No. 23.

„ „ Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 48.

Estuary of the Dee, very rare (Siddall).

Polymorphina lanceolata, Reuss.

Polymorphina lanceolata, Reuss, 1851, Zeitschr. d. deutsch. geol. Gesell., vol. iii. p. 83, pl. vi. fig. 50.

„ *fusiformis*, pars, Brady, Parker and Jones, 1870, Trans. Linn. Soc. Lond., vol. xxvii. p. 219, pl. xxxix. fig. 5, b, c.

„ *lanceolata*, Robertson, 1882, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 268.

Robin Hood's Bay, Yorkshire; Loch Fyne (Robertson); estuary of the Dee (Siddall); Dublin coast (Balkwill and Wright); south-west of Ireland (Wright). Probably this list is far from complete.

Polymorphina cylindroides, Roemer.

Polymorphina cylindroides, Roemer, 1838, Neues Jahrb. für Min., &c.,
p. 385, pl. iii. fig. 26.

„ *lactea*, var. *acuminata*, Williamson, 1858, Rec. For. Gt.
Br., p. 71, pl. vi. fig. 148.

Skye (Williamson); Shetland (Waller).

Polymorphina compressa, d'Orbigny.

Polymorphina compressa, d'Orbigny, 1846, For. Foss. Vien., p. 233,
pl. xii. figs. 32-34.

„ *lactea (typica)*, pars, Williamson, 1858, Rec. For. Gt.
Br., p. 70, pl. vi. figs. 145, 146.

Generally distributed.

Polymorphina complanata, d'Orbigny.

Polymorphina complanata, d'Orbigny, 1846, For. Fos. Vien., p. 234,
pl. xiii. figs. 25-30.

„ „ Balkwill and Millett, 1884, Journ. Microsc.
and Nat. Sci., vol. iii. p. 84, pl. iv. fig. 9.

Shore-sand, Galway (Balkwill and Millett).

Polymorphina sororia, Reuss.

Polymorphina (Guttulina) sororia, Reuss, 1862, Bull. Acad. Roy. Belg.,
sér. 2, vol. xv. p. 151, pl. ii. figs. 25-29.

„ *sororia*, Robertson, 1882, Proc. Nat. Hist. Soc. Glasgow,
vol. v. p. 268.

The cuspidate variety of this form has been dredged by Mr. Robertson in Loch Fyne, and by Mr. Wright off the south-west of Ireland.

Polymorphina rotundata, Bornemann, sp.

Guttulina rotundata, Bornemann, 1855, Zeitschr. d. deutsch. geol.
Gesell., vol. vii. p. 346, pl. xviii. fig. 3.

Polymorphina rotundata, Robertson, 1882, Proc. Nat. Hist. Soc.
Glasgow, vol. v. p. 268.

Oban and Loch Fyne (Robertson); north of Ireland (Wright);
Dublin coast (Balkwill and Wright).

Polymorphina concava, Williamson.

Polymorphina lactea, var. *concava*, Williamson, 1858, Rec. For. Gt.
Br., p. 72, pl. vi. figs. 151, 152.

Brixham (Williamson); estuary of the Dee (Siddall); South Donegal
(Wright); south-west of Ireland, 110 fathoms (Wright); Mount's Bay
(Millett); Dublin coast (Balkwill and Wright).

Polymorphina myristiformis, Williamson.

Polymorphina myristiformis, Williamson, 1858, Rec. For. Gt. Br.,
p. 73, pl. vi. figs. 156, 157.

Widely distributed, and in certain localities very common.

Polymorphina spinosa, d'Orbigny, sp.

Globulina spinosa, d'Orbigny, 1846, For. Foss. Vien., p. 230, pl. xiii. figs. 23, 24.

Polymorphina spinosa, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 48.

Estuary of the Dee, very rare (Siddall); Dublin coast, very rare (Balkwill and Wright).

UVIGERINA, d'Orbigny.

Uvigerina pygmæa, d'Orbigny.

Uvigerina pygmæa, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 269, No. 2, pl. xii. figs. 8, 9;—Modèle, No. 67.

„ „ Williamson, 1858, Rec. For. Gt. Br., p. 66, pl. v. figs. 138, 139.

Not uncommon at depths of 30 fathoms and more; rarely met with in shallower water.

Uvigerina angulosa, Williamson.

Uvigerina angulosa, Williamson, 1858, Rec. For. Gt. Br., p. 67, pl. v. fig. 140.

Much more frequent in our seas than the typical form *U. pygmæa*, and occurring in shallower water.

Uvigerina canariensis, d'Orbigny.

Uvigerina canariensis, d'Orbigny, 1839, Foram. Canaries, p. 138, pl. i. figs. 25-27.

„ *irregularis*, Brady, 1865, Nat. Hist. Trans. Northd. and Durham, vol. i. p. 100, pl. xii. fig. 5.

Off Holy Island (Brady); estuary of the Dee (Siddall); south-west of Ireland (Wright); in all of these localities very rare.

SAGRINA, Parker and Jones.

Sagrina dimorpha, Parker and Jones.

Uvigerina (Sagrina) dimorpha, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 420, pl. xviii. fig. 18.

Mr. Robertson has tolerably well-marked specimens of this form from low-water, Howport, Girvan.

Sub-family 4. **Ramulininæ.**

RAMULINA, Rupert Jones.

(?) *Ramulina globulifera*, Brady.

Ramulina globulifera, Brady, 1869, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 58, pl. viii. figs. 32, 33.

„ sp. Balkwill and Millett, 1884, Journ. Microsc. and Nat. Sci., vol. iii. p. 83, pl. iv. fig. 7.

Shore-sand, Galway (Balkwill and Millett).

I have placed the broken specimen, figured by the authors above named, provisionally under this species, but it is impossible to speak with much confidence on so slender a groundwork.

Family VIII. GLOBIGERINIDÆ.

GLOBIGERINA, d'Orbigny.

Globigerina bulloides, d'Orbigny.

- Globigerina bulloides*, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 277, No. 1;—Modèles, No. 17 (young) and No. 76.
 „ „ Williamson, 1858, Rec. For. Gt. Br., p. 56, pl. v. figs. 116–118.

Comparatively rare on the east coast; common at some distance from land on the Atlantic shores.

Globigerina inflata, d'Orbigny.

- Globigerina inflata*, d'Orbigny, 1839, Foram. Canaries, p. 134, pl. ii. figs. 7–9.
 „ „ Wright, 1881, Proc. Belfast Nat. Field Club, 1880–81, Appendix, p. 186.

South Donegal (Wright); Irish Sea (Balkwill and Wright); south-west of Ireland (Wright); shore-sand, Galway (Balkwill and Millett); Mount's Bay, Cornwall (Millett); Shetland (Brady).

Globigerina rubra, d'Orbigny.

- Globigerina rubra*, d'Orbigny, 1839, Foram. Cuba, p. 94, pl. iv. figs. 12–14.
 „ „ Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 613.

South-west of Ireland, 100 to 200 fathoms, rare (Wright).

Globigerina æquilateralis, Brady.

- Globigerina æquilateralis*, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 285.
 „ „ Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 613.

South-west of Ireland, 48–120 fathoms, rare (Wright); Shetland (Brady).

ORBULINA, d'Orbigny.

Orbulina universa, d'Orbigny.

- Orbulina universa*, d'Orbigny, 1839, Foram. Cuba, p. 3, pl. i. fig. 1.
 „ „ Williamson, 1858, Rec. For. Gt. Br., p. 2, pl. i. fig. 4.

Rare near land, but in deeper water not uncommon, especially on the south and west coasts. Shallow-water specimens often of brown colour. Double specimens, the *Globigerina bilobata* of d'Orbigny, occasionally met with where the species is plentiful.

PULLENIA, Parker and Jones.

Pullenia sphæroides, d'Orbigny, sp.

Nonionina sphæroides, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 293, No. 1;—Modèle, No. 43.

Pullenia sphæroides, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 49.

Estuary of the Dee (Siddall); Irish Sea (Balkwill and Wright).

Pullenia quinqueloba, Reuss.

Nonionina quinqueloba, Reuss, 1851, Zeitschr. d. deutsch. geol. Gesell., vol. iii. p. 71, pl. v. fig. 31.

Pullenia quinqueloba, Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 348, pl. 12, figs. 29 *a, b*.

Lambay Deep, 45 fathoms (Balkwill and Wright); south-west of Ireland (Wright); Shetland (Brady).

SPHÆROIDINA, d'Orbigny.

Sphæroidina bulloides, d'Orbigny.

Sphæroidina bulloides, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 267, No. 1;—Modèle, No. 65.

„ „ Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 613.

South-west of Ireland, 54 to 120 fathoms (Wright).

Mr. Siddall informs me that the specimen assigned to this species in the Dee Catalogue of 1878 appears to be a starved example of *Sph. dehiscens*, under which it is now placed.

Sphæroidina dehiscens, Parker and Jones.

Sphæroidina dehiscens, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 369, pl. xix. fig. 5.

„ „ Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 58.

One example from the Dee estuary (Siddall).

Family IX. ROTALIDÆ.

Sub-family 1. Spirillininæ.

SPIRILLINA, Ehrenberg.

Spirillina vivipara, Ehrenberg.

Spirillina vivipara, Ehrenberg, 1841, Abhandl. k. Akad. Wiss. Berlin, p. 442, pl. iii. fig. 41.

„ *perforata*, Williamson, 1858, Rec. For. Gt. Br., p. 92, pl. vii. fig. 202.

Generally distributed; specimens, however, not very common.

Spirillina limbata, Brady.

Spirillina limbata, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 278, pl. viii. fig. 26.

Spirillina limbata, Siddall, 1886, Proc. Lit. Phil. Soc. Liverpool, vol. xl. Appendix, p. 59.
Estuary of the Dee, very rare (Siddall).

Spirillina margaritifera, Williamson.

Spirillina margaritifera, Williamson, 1858, Rec. For. Gt. Br., p. 93, pl. vii. fig. 204.
Estuary of the Dee (Siddall); Mounts Bay, Cornwall (Millett; Williamson gives no locality).

Spirillina tuberculata, Brady.

Spirillina tuberculata, Brady, 1878 (in Siddall's 'Foraminifera of the Dee'), Proc. Chester Soc. Nat. Sci., pt. ii. p. 49;—1879, Quart. Journ. Micr. Sci., vol. xix. N.S. p. 279, pl. viii. fig. 28.
Off Eddystone (Robertson); estuary of the Dee (Siddall); at several points off the coast of Dublin, and in the Irish Sea (Balkwill and Wright).

I am not by any means confident that this form, or at any rate the British specimens that have been assigned to it, can be separated from *Sp. margaritifera*. Some of the Challenger specimens, notably those from Kerguelen, differ strikingly from Williamson's figure; but then Williamson had only a single specimen, and it may be questioned how far it was typical.

Sub-family 2. Rotalinæ.

PATELLINA, Williamson.

Patellina corrugata, Williamson.

Patellina corrugata, Williamson, 1858, Rec. For. Gt. Br., p. 46, pl. iii. figs. 86–89.

Occurs at intervals all round the coast, usually on muddy bottoms.

DISCORBINA, Parker and Jones.

Discorbina globularis, d'Orbigny, sp.

Rosalina globularis, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 271, No. 1, pl. xiii. figs. 1–4;—Modèle, No. 69.

Rotalina concamerata (young), Williamson, 1858, Rec. For. Gt. Br., p. 53, pl. iv. figs. 104, 105.
Common everywhere.

Discorbina rosacea, d'Orbigny, sp.

Rotalia rosacea, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 273, No. 15;—Modèle, No. 39.

Rotalina mamilla, Williamson, 1858, Rec. For. Gt. Br., p. 54, pl. iv. figs. 109–111.
Widely distributed.

Discorbina orbicularis, Terquem, sp.

Rosalina orbicularis, Terquem, 1876, Anim. sur la Plage de Dunkerque, fasc. ii. p. 75, pl. ix. fig. 4.

Discorbina orbicularis, Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 349, pl. xiii. figs. 31-33.

At several points off the Dublin coast, and in the Irish Sea (Balkwill and Wright); Mount's Bay, Cornwall (Millett); shore-sand, Galway (Balkwill and Millett).

Discorbina parisiensis, d'Orbigny, sp.

Rosalina parisiensis, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 271, No. 1;—Modèle, No. 38.

Discorbina parisiensis (pars), Wright, 1877, Proc. Belfast Nat. Field Club, 1876-7, Appendix, p. 105, pl. iv. fig. 1.

South Donegal; Down and Antrim (Wright); Dublin coast and Irish Sea (Balkwill and Wright); shore-sand, Galway (Balkwill and Millett); Mount's Bay (Millett).

Discorbina wrightii, Brady.

Discorbina wrightii, Brady, 1881, Denkschr. d. k. Akad. Wiss. Wien, vol. xliii. p. 104, pl. ii. fig. 6;—Ann. and Mag. Nat. Hist., ser. 5, vol. viii. p. 413, pl. xxi. fig. 6.

„ *parisiensis* (pars), Wright, 1877, Proc. Belfast Nat. Field Club, 1876-7, Appendix, p. 105, pl. iv. fig. 2.

Coasts of Down and Antrim, and of South Donegal (Wright); various points in the Irish Sea (Balkwill and Wright); shore-sand, Galway (Balkwill and Millett).

In Mr. Siddall's Catalogue of British Recent Foraminifera (1879), *Discorbina obtusa*, d'Orbigny, sp., was included, on the evidence of one or two small specimens, found by myself many years ago in sands dredged amongst the Hebrides; I am now inclined to think, however, that these are better referred to the present closely allied species.

Discorbina tuberculata, Balkwill and Wright.

Discorbina tuberculata, Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 350, pl. xiii. figs. 28-30.

Off Dublin coast, and in the Irish Sea (Balkwill and Wright); estuary of the Dee (Siddall).

Discorbina bertheloti, d'Orbigny, sp.

Rosalina bertheloti, d'Orbigny, 1839, Foram. Canaries, p. 135, pl. i. figs. 28-30.

Discorbina bertheloti, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 469, pl. xlviii. fig. 10.

Shetland (Brady, Waller); various points on the coast of Ireland and in the Irish Sea (Wright, Balkwill and Wright, Balkwill and Millett).

Discorbina biconcava, Parker and Jones.

Discorbina biconcava, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 422, pl. xix. fig. 10.

Discorbina biconcava, Siddall, 1878, Proc. Chester Soc. Nat. Sci., pt. ii. p. 50.

Estuary of the Dee (Siddall).

PLANORBULINA, d'Orbigny.

Planorbulina mediterraneensis, d'Orbigny.

Planorbulina mediterraneensis, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 280, No. 2, pl. xiv. figs. 4-6;—Modèle, No. 79.

„ *vulgaris*, Williamson, 1858, Rec. For. Gt. Br., p. 57, pl. v. figs. 119, 120.

Generally distributed.

TRUNCATULINA, d'Orbigny.

Truncatulina refulgens, Montfort, sp.

Cibicides refulgens, Montfort, 1808, Conchyl. Systém., vol. i. p. 122, 31^e Genre.

Truncatulina refulgens, Brady, 1865, Nat. Hist. Trans. Northd. and Durham, vol. i. p. 105, pl. xii. fig. 9.

Not uncommon in coarse rough sands, from 20 fathoms downwards, on the Atlantic coasts of Scotland and Ireland; rare on the east coast.

Truncatulina lobatula, Walker and Jacob, sp.

Nautilus lobatulus, Walker and Jacob, 1798, Adams's Essays, Knaumacher's ed., p. 642, pl. xiv. fig. 36.

Truncatulina lobatula, Williamson, 1858, Rec. For. Gt. Br., p. 59, pl. v. figs. 121-123.

One of the commonest British species.

Specimens closely resembling a compact many-chambered variety of *Truncatulina*, recently described by Messrs. Parker and Jones and myself in a paper on some Foraminifera from the Abroghos Bank (Trans. Zool. Soc. Lond., vol. xii., in the press), are common in Mr. Wright's material from south-east of Ireland. This has been named *Truncatulina mundula*, and the following characters are given for its identification, *loc. cit.* Morphologically its place is near *Tr. haidingerii*, or between that species and *Tr. ungeriana*, its nearest isomorph being *Pulvinulina karsteni*.

“*Truncatulina mundula*, B. P. and J.—Test free, rotaliform; composed of about three convolutions, which are evolute on the superior and completely involute on the inferior side; the outermost whorl of the adult shell consisting of from ten to twelve segments. Superior face slightly convex or subconical, generally coarsely perforate, the sutures and periphery marked by thickening of the chamber-walls; inferior face convex, sometimes a little depressed at the umbilicus, perforations inconspicuous, sutures slightly excavated or marked by fine lines only. Diameter $\frac{1}{60}$ in. (0.42 mm.).” The Irish specimens have rather fewer chambers than above indicated, but otherwise present very similar characters.

Truncatulina haidingerii, d'Orbigny, sp.

Rotalina haidingerii, d'Orbigny, 1846, For. Foss. Vien., p. 154, pl. viii. figs. 7-9.

Planorbulina haidingerii, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 469, pl. xlviii. fig. 11.

Shetland, 79 to 90 fathoms (Brady, Waller); estuary of the Dee (Siddall);—the examples, so far as they have come under my notice, not very typical.

Truncatulina ungeriana, d'Orbigny, sp.

Rotalina ungeriana, d'Orbigny, 1846, For. Foss. Vien., p. 157, pl. viii. figs. 16-18.

Planorbulina ungeriana, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 469, pl. xlviii. fig. 12.

Shetland, 75 to 90 fathoms (Brady, Waller); estuary of the Dee (Siddall); south-west of Ireland (Wright).

ANOMALINA, d'Orbigny.

Anomalina coronata, Parker and Jones.

Anomalina coronata, Parker and Jones, 1857, Ann. and Mag. Nat. Hist., ser. 2, vol. xix. p. 294, pl. x. figs. 15, 16.

„ „ Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 469, pl. xlviii. fig. 13.

Shetland, 75 to 90 fathoms (Brady, Waller).

PULVINULINA, Parker and Jones.

Pulvinulina repanda, Fichtel and Moll, sp.

Nautilus repandus, Fichtel and Moll, 1803, Test. Micr., p. 35, pl. iii. figs. a-d.

Rotalina concamerata (mature), Williamson, 1858, Rec. For. Gt. Br., p. 52, pl. iv. figs. 101-103.

The typical *Pulvinulina repanda* is represented by Fichtel and Moll as a Rotaline shell with its two faces nearly equally convex. The form figured by Williamson, and generally met with on our shores, is much more convex on the superior side than on the inferior, and the sutures of the superior aspect are marked by a certain amount of external thickening or limbation. The latter form may be distinguished as var. *concamerata*, Montagu, but it is impossible to separate the two by any very constant characters.

I find no record of the occurrence of *Pulvinulina repanda* on the east coast of England or Scotland, nor in the Irish Sea. It is not uncommon in coarse sands dredged on the north and west coasts of Scotland and Ireland, and in the English Channel.

Pulvinulina concentrica, Parker and Jones.

Pulvinulina concentrica, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 393.

Pulvinulina concentrica Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 470, pl. xlviii. fig. 14.
Shetland, 75 to 90 fathoms (Brady, Waller).

Pulvinulina auricula, Fichtel and Moll, sp.

Nautilus auricula, var. *a*, Fichtel and Moll, 1803, Test. Micr., p. 108, pl. xx. figs. *a, b, c*.

var. *β*, Id., Ibid., figs. *d, e, f*.

Rotalina oblonga, Williamson, 1858, Rec. For. Gt. Br., p. 51, pl. iv. figs. 98-100.

Widely distributed.

Pulvinulina menardii, d'Orbigny, sp.

Rotalia menardii, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 273, No. 26;—Modèle, No. 10.

Pulvinulina menardii, Brady, 1863, Report Brit. Assoc., Newcastle-upon-Tyne Meeting, Trans. p. 101.

Off Laxey, Isle of Man, 15 fathoms (Brady); Irish Sea and coast of Dublin (Balkwill and Wright).

Pulvinulina canariensis, d'Orbigny, sp.

Rotalina canariensis, d'Orbigny, 1839, Foram. Canaries, p. 130, pl. i. figs. 34-36.

Pulvinulina canariensis, Brady, 1870, Edinburgh Catalogue, p. 8.

Hebrides (Brady); estuary of the Dee (Siddall); shore-sand, Galway (Balkwill and Millett); south-west of Ireland (Wright).

Pulvinulina patagonica, d'Orbigny, sp.

Rotalina patagonica, d'Orbigny, 1839, Foram. Amér. Mérid., p. 36, pl. ii. figs. 6-8.

Pulvinulina scitula, Balkwill and Millett, 1884, Journ. Micr. and Nat. Sci., vol. iii. p. 85, pl. iv. fig. 12.

Shore-sand, Galway, a single specimen (Balkwill and Millett); south-west of Ireland, 54 to 120 fathoms, rare; off Belfast Lough, 30 to 60 fathoms, very rare (Wright).

Pulvinulina micheliniana, d'Orbigny, sp.

Rotalina micheliniana, d'Orbigny, 1840, Mém. Soc. géol. France, vol. iv. p. 31, pl. iii. figs. 1-3.

Pulvinulina micheliniana, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 614.

Various points to the south-west of Ireland, 48 to 120 fathoms (Wright).

Pulvinulina crassa is inserted in the 'Edinburgh Catalogue' (p. 8), on the ground of one or two specimens believed to be referrible to that species obtained from Mr. Jeffreys' Hebrides dredgings. The mounting has unfortunately been mislaid, but it appears to me not improbable that the shells in question may have belonged to the present closely allied form; at any rate, without more evidence than at present exists, the retention of the name in the British list is scarcely warranted.

Pulvinulina karsteni, Reuss, sp.

Rotalia karsteni, Reuss, 1855, Zeitschr. d. deutsch. geol. Gesell., vol. vii. p. 273, pl. ix. fig. 6.

Pulvinulina karsteni, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 470, pl. xlviii. fig. 15.

Shetland, 75 to 90 fathoms (Brady, Waller); South Donegal (Wright); Irish Sea and Dublin coast (Balkwill and Wright); south-west of Ireland, 79 to 120 fathoms (Wright).

Pulvinulina elegans, d'Orbigny, sp.

Rotalia (Turbinulina) elegans, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 276, No. 54;—Soldani, Saggio Oritt., p. 99, pl. ii. fig. 13.

Rotalina partschiana, d'Orbigny, 1846, For. Foss. Vien., p. 153, pl. vii. figs. 28–30; pl. viii. figs. 1–3.

Pulvinulina elegans, Brady, 1870, Edinburgh Catalogue, p. 7.

Off Laxey, Isle of Man, 15 fathoms; Guernsey, dredged (Brady); south-west of Ireland, 48 to 120 fathoms (Wright).

ROTALIA, Lamarek.

Rotalia beccarii, Linné, sp.

Nautilus beccarii, Linné, 1767, Syst. Nat., 12th ed., p. 1162;—1788, Ibid., 13th (Gmelin's) ed., p. 3370, No. 4.

Rotalina beccarii, Williamson, 1858, Rec. For. Gt. Br., p. 48, pl. iv. figs. 90–92.

Generally distributed.

Rotalia orbicularis, d'Orbigny.

Rotalia (Gyroidina) orbicularis, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 278, No. 1;—Modele, No. 13.

„ *orbicularis*, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 470, pl. xlviii. fig. 16.

Irish Sea; Shetland (Brady); south-west of Ireland, 100 to 200 fathoms (Wright).

Rotalia nitida, Williamson.

Rotalina nitida, Williamson, 1858, Rec. For. Gt. Br., p. 54, pl. iv. figs. 106–8.

Found at intervals all round the coast.

Sub-family 3. **Tinoporinæ.**

GYPSINA, Carter.

Gypsina vesicularis, Parker and Jones, sp.

Orbitolina vesicularis, Parker and Jones, 1860, Ann. and Mag. Nat. Hist., ser. 3, vol. vi. p. 31, No. 5.

Tinoporus lævis, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 470, pl. xlviii. fig. 17.

Not uncommon on the Atlantic sea-board and in the Irish Sea; not recorded from the east coast of England or Scotland.

Gypsina globulus, Reuss, sp.

Ceriodora globulus, Reuss, 1847, Haidinger's Naturw. Abhandl., vol. ii. p. 33, pl. v. fig. 7.

Gypsina globulus, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. (Science) p. 614.

A single large specimen reported by Wright from 110 fathoms, south-west of Ireland.

Gypsina inhærens, Schultze, sp.

Acervulina inhærens, Schultze, 1854, Organ. der Polythal., p. 68, pl. vi. fig. 12.

Tinoporos lucidus, Brady, 1870, Edinburgh Catalogue, p. 8.

Generally distributed.

Family X. NUMMULINIDÆ.

Sub-family 1. Fusulininæ.

Sub-family 2. Polystomellinæ.

NONIONINA, d'Orbigny.

Nonionina asterizans, Fichtel and Moll.

Nautilus asterizans, Fichtel and Moll, 1803, Test. Micr., p. 37, pl. iii. figs. e-h.

Nonionina asterizans, Brady, 1870, Edinburgh Catalogue, p. 8.

Since becoming better acquainted with the typical *Nonionina asterizans*, through the 'Challenger' collections, I have had considerable doubt whether the species has any claim to a place in the British list. The British specimens which have come under my notice have all been minute, and their characters ambiguous; and I am inclined to think they might generally be referred either to *N. depressula* on the one hand, or *N. stelligera* on the other. Of the distribution of *N. asterizans* as distinct from these two forms there is no satisfactory information.

Nonionina depressula, Walker and Jacob, sp.

Nautilus depressulus, Walker and Jacob, 1798, Adams's Essays, Kammacher's ed., p. 641, pl. xiv. fig. 33.

Nonionina umbilicatula, Williamson, 1858, Rec. For. Gt. Br., p. 97, pl. iii. figs. 70, 71.

„ *crassula*, Id., Ibid., p. 33.

Generally distributed; one of the commonest Microzoa of shallow pools and estuaries, and of brackish water.

Nonionina umbilicatula, Montagu, sp.

Nautilus umbilicatus, Montagu, 1803, Test. Brit., p. 191;—Suppl., p. 78, pl. xviii. fig. 1.

Nonionina barleena, Williamson, 1858, Rec. For. Gt. Br., p. 32, pl. iii. figs. 68, 69.

Widely distributed; affecting much deeper water than the last-named species.

Nonionina orbicularis, Brady.

Nonionina orbicularis, Brady, 1881, Denkschr. d. k. Akad. Wiss. Wien, vol. xliii. p. 105, pl. ii. fig. 5;—Ann. and Mag. Nat. Hist., ser. 5, vol. viii. p. 415, pl. xxi. fig. 5.

„ „ Robertson, 1882, Proc. Nat. Hist. Soc. Glasgow, vol. v. p. 274.

Loch Fyne, 25 fathoms (Robertson); off Valentia, 112 fathoms (Norman); south-west of Ireland, 79 to 120 fathoms (Wright).

Nonionina boueana, d'Orbigny.

Nonionina boueana, d'Orbigny, 1846, For. Foss. Vien., p. 108, pl. v. figs. 11, 12.

„ „ Balkwill and Millett, 1884, Journ. Micr. and Nat. Sci., vol. iii. p. 85.

Shore-sand Galway? (Balkwill and Millett).

This is not a very satisfactory "species" at best. The shell figured by Messrs. Balkwill and Wright (Trans. R. Irish Acad., vol. xxviii. (Science) pl. xiii. fig. 27) shows the double rows of sutural orifices characteristic of *Polystomella arctica*, and I learn that the authors are now disposed to transfer it to that species. The right of *Nonionina boueana* therefore to a place in the present list depends upon Messrs. Balkwill and Millett's doubtful specimens.

Nonionina pauperata, Balkwill and Wright.

Nonionina pauperata, Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 353, p. xiii. figs. 25, 26.

Dublin coast, and various points in the Irish Sea, rather frequent (Balkwill and Wright); south-west of Ireland, 26 fathoms (Wright).

Possibly only the starved condition of *Nonionina scapha*.

Nonionina turgida, Williamson, sp.

Rotalina turgida, Williamson, 1858, Rec. For. Gt. Br., p. 50, pl. iv. figs. 95-97.

Tolerably frequent all round the coast.

Nonionina scapha, Fichtel and Moll, sp.

Nautilus scapha, Fichtel and Moll, 1803, Test. Micr., p. 105, pl. xix. figs. d-f.

Nonionina scapha, Brady, 1865, Nat. Hist. Trans. Northd. and Durham, vol. i. p. 106, pl. xii. fig. 10.

Durham coast (Brady); west of Scotland (Robertson); estuary of the Dee (Siddall); shore-sand, Galway? (Balkwill and Millett); coast of Down and Antrim; south-west of Ireland, 40 to 120 fathoms (Wright).

Nonionina stelligera, d'Orbigny.

Nonionina stelligera, d'Orbigny, 1839, Foram. Canaries, p. 128, pl. iii. figs. 1, 2.

Nonionina stelligera, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 471, pl. xlviii. fig. 19.

Shetland, 80 fathoms (Brady, Waller); estuary of the Dee (Siddall); Mount's Bay (Millett); shore-sand, Galway (Balkwill and Millett); Dublin Bay and Irish Sea (Balkwill and Wright); south-west of Ireland (Wright).

POLYSTOMELLA, Lamarck.

Polystomella crispa, Linné, sp.

Nautilus crispus, Linné, 1767, Syst. Nat., 12th ed., p. 1162, 275;—1788, Ibid., 13th (Gmelin's) ed., p. 3370, No. 3.

Polystomella crispa, Williamson, 1858, Rec. For. Gt. Br., p. 40, pl. iii. figs. 78–80.

Common at all parts of the coast.

Polystomella subnodosa, Münster, sp.

Robulina subnodosa, Münster, 1838 (*fide* Roemer), Neues Jahrb. für Min. &c., p. 391, pl. iii. fig. 61.

Polystomella subnodosa, Wright, 1886, Proc. R. Irish Acad., ser. 2 vol. iv. (Science) p. 614.

South-west of Ireland, 100 to 120 fathoms, frequent (Wright).

Polystomella striatopunctata, Fichtel and Moll, sp.

Nautilus striatopunctatus, Fichtel and Moll, 1803, Test. Micr., p. 61, pl. ix. fig. a-c.

Polystomella umbilicatulula, Williamson, 1858, Rec. For. Gt. Br., p. 42, pl. iii. figs. 81, 82.

var. *incerta*, Id., Ibid., p. 44, pl. iii. fig. 82 a.
Generally distributed.

Polystomella arctica, Parker and Jones.

Polystomella crispa, var. *arctica*, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 401, pl. xiv. figs. 25–30.

„ *arctica*, Brady, 1864, Trans. Linn. Soc. Lond., vol. xxiv. p. 471, pl. xlviii. fig. 18.

Shetland, 75 to 90 fathoms (Brady, Waller); between Portincross and Ardrrossan, 30 fathoms (Robertson); Kish Bank, 24 fathoms, very rare (Balkwill and Wright—described and figured as *Nonionina boueana* in their memoir).

Sub-family 3. Nummulitinæ.

OPERCULINA, d'Orbigny.

Operculina ammonoides, Gronovius, sp.

Nautilus ammonoides, Gronovius, 1781, Zooph. Gron., p. 282, No. 1220; and p. v.

Nonionina elegans, Williamson, 1858, Rec. For. Gt. Br., p. 35, pl. iii. figs. 74, 75.

Shetland, Hebrides (Williamson, Brady, Waller); Scarborough (Williamson); south-west of Ireland (Wright).

POSTSCRIPT.—Since the foregoing Synopsis has been in type I have received from my friend M. Schlumberger a copy of a valuable communication, recently made by him to the Zoological Society of France, on the genus *Planispirina* (Bull. Soc. Zool. France, vol. xii. pp. 105–118, pl. vii.), containing a further instalment of his interesting researches on the construction of the test in the various types of *Miliolidae*. M. Schlumberger's examination of the forms referred to the genus *Planispirina* in the 'Challenger Report' has led him to the conclusion that they exemplify two diverse types of structure sufficiently distinct for generic separation,—one group, for which the term *Planispirina* is retained, embracing *Pl. (Biloculina) contraria*, d'Orb., *Pl. communis*, Seg., and *Pl. carinata*, Seg. (and, I suppose, *Pl. exigua*, Brady); the other, for which the generic name *Sigmoilina* is proposed, including *Planispirina sigmoidea*, Brady, *Pl. (Spiroloculina) celata*, Costa, and a new species *Sigmoilina edwardsi*, Schlumberger, together with *Quinqueloculina secans*, d'Orb., and *Quinqueloculina tenuis*, Czjzek.

It is not needful here to discuss the relative value of the characters upon which this arrangement is founded. The construction of the test in the species concerned has been worked out with the author's accustomed skill and accuracy, and so far as can be judged the results bear out the conclusions at which he has arrived. That the difficulties referred to on a previous page, as to the position of apparently intermediate forms, like *Quinqueloculina tenuis* and *Q. secans*, are thereby disposed of, is an additional argument in favour of the suggested relationship.

The acceptance of this view would only affect the nomenclature of the present paper in connection with three species, namely,—*Planispirina celata*, *Miliolina secans*, and *Miliolina tenuis*, which would stand respectively as *Sigmoilina celata*, Costa, sp., *Sigmoilina secans*, d'Orb., sp., and *Sigmoilina tenuis*, Czjzek, sp.

XV.—*A New Eye-piece.*

By E. M. NELSON.

(Read 9th November, 1887.)

UNTIL quite lately, there have been among Microscopists only two kinds of eye-pieces in general use, viz. the Huyghenian and the Kellner. Recently, however, Prof. Abbe's compensating eye-pieces have been introduced with beneficial results. Of these three forms the Kellner may be dismissed by saying that although one of its lenses is achromatized, its defining power is undoubtedly considered bad by general consent.

The compensating eye-pieces, while being absolutely necessary to some of the apochromatic series of objectives and beneficial to others, improve the definition of ordinary objectives also.

Having for some time past made a great many experiments with achromatic eye-pieces of doubles, triples, and other forms, I may sum up my results by saying that I had not succeeded in producing any combination whose defining power surpassed that of the Huyghenian.

When I saw the increase of defining power given by the compensating eye-pieces, I determined to reopen my investigations.

The theoretical action of the Huyghenian eye-piece requires that an over-corrected image should be received by the field-lens, the over-correction to be of such an extent that the under-corrected field-lens of the eye-piece is not able to neutralize it, but leaves it still over-corrected by an amount equal to the under-correction of the eye-lens. I must say that my surprise was great on obtaining better definition with Prof. Abbe's over-corrected eye-pieces used in conjunction with the supposed over-corrected ordinary achromatic objectives. I concluded, therefore, that by reducing the under-correction of the eye-lens of the Huyghenian eye-piece better definition would be secured.

We know that in the formula for aberration—

$$-\Delta f : \frac{y^2}{f} = \frac{\mu - 1}{2\mu^2} \left\{ \frac{1}{r^3} + \left(\frac{\mu + 1}{f} - \frac{1}{r'} \right) \left(\frac{1}{f} - \frac{1}{r'} \right)^2 \right\} f^3$$

and where f = principal focus; y = semi-aperture; μ = ref. index and r, r' , = radii; if we put $r = \infty$, and $-r' = \frac{f}{2}$ we get the aberration for a plano-convex lens having its convex side to the focus; in other words, the eye-lens of a Huyghenian eye-piece, viz. $\Delta f = -\frac{9}{2} \frac{y^2}{f}$.

If, however, we invert the lens, $\Delta f = -\frac{7}{6} \frac{y^2}{f}$ or about 1/4 of what it was before. I therefore concluded that by the inversion of the eye-lens there would be an improvement in the definition though a loss in the size of the field.

In practice I found these conclusions verified. The best results were obtained by achromatizing the eye-lens, i. e. by making it of a biconvex and a plano-concave, with its convex side towards the eye. The aperture in the diaphragm was reduced until the diameter of the field was equal to that of the Abbe compensating eye-piece.

This eye-piece, with the achromatized eye-lens, gives the sharpest images I have seen. It works perfectly well with the 24 mm. and 3 mm. Zeiss apochromatic objectives.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Fertilization and Segmentation of the Animal Ovum.‡—Drs. O. and R. Hertwig have made a series of experiments on animal ova with the object of affecting, by chemical, thermal, and mechanical agencies, (1) fertilization, (2) the process of the internal phenomena of fertilization, and (3) segmentation.

In considering the mode of action of the reagents used, attention must be given to the degree of concentration of the chemical reagents, and the differences in the temperature applied; the time, also, during which the modifying influence is allowed to exert itself is important.

The movements of spermatozoa were found to be stopped by slight doses of quinine or chloral, but as, on addition of fresh water, they recovered themselves it is clear they were not killed, but only had their contractility affected; their reproductive power was not impaired. Morphia, moderately strong solutions of strychnine, and nicotine seem to exert no influence on spermatozoa; a very strong solution of nicotine, acting for an hour, appears to produce changes in the spermatozoa.

The formation of the fertilization-sphere, or that elevation of the ovarian protoplasm which marks the point of entrance of the spermatozoa, appears to be affected by chloral or quinine; slight heating (up to 31° C.) produces at first an increase in the size of the sphere; higher temperatures and greater length of exposure have the same effect as quinine. Morphia, strychnine, and nicotine have no effect.

As to the effect of reagents on segmentation, it was found that 0·6 per cent. solution of morphia does not affect the ova, and that they will continue to divide for a day in a 1 per cent. solution; strychnine and nicotine have no, but quinine, chloral, and heat have a distinctly weakening effect. Eggs placed in water of 32° C. for ten minutes never completely regain their power of segmentation.

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Jenaisch. Zeitschr. f. Naturwiss., xx. (1887) pp. 120-241, 477-510 (5 pls.).

The changes produced by quinine and chloral on dividing ova affect the nucleus as well as the protoplasm, and the phenomena of karyokinesis may be seen to be disturbed by these reagents.

It would seem to be certain that the most important matter is the diminution of the contractile power of the reproductive elements, and this is proved not only by the quiescence of the spermatozoa, but by the stoppage of segmentation and the retrograde metamorphosis which is undergone by the nucleus.

If the view be correct that quinine and chloral have weakening, and nicotine and strychnine slightly stimulating effects on the contractility of the egg, it is clear that we have fresh means for investigating the significance of the formation of rays in the interior of the ovum. The authors regard the sperm-nucleus and the ends of the segmentation-nucleus as centres of stimuli which have an effect on the protoplasm. It is natural that the homogeneous constituents of the protoplasm, which are the seat of contractility, should stream towards the point of stimulation, and they produce an aggregation of elements; but it is further probable that the movement should take place in a radial manner, and should thus exercise a directive influence on the passive parts—the granules. But this directive influence can only be exercised so long as the movement which causes it is energetic; if it is slowed by any agent, the granules would retain their position, and the homogeneous protoplasm would alone be collected around the nucleus.

Armed by the knowledge of abnormal phenomena which they have acquired, the Drs. Hertwig regard the ray-figures given by Carnoy as pathological conditions. Increased irritability, weakening, and polyspermy are not the only changes which may be caused in eggs by external influences; in addition, there are changes in the chemical composition of the substances forming the egg, and that even before the approach of death.

In dealing with the process of fertilization, it is pointed out that abnormal fertilization may occur when spermatozoa of another species come in contact with the egg, or if many spermatozoa of the same species enter the egg (polyspermy). In inquiring as to the arrangements which prevent abnormal fertilization, the first point of importance is this: no peculiar properties can be observed in the egg which can be regarded as aiding in normal fertilization; spermatozoa appear to have the tendency to enter any eggs, and in any quantities. Few experiments have been made on this point, but it has been observed that eggs which were sufficiently under the influence of chloroform showed no increased tendency to bastardation. It would, therefore, appear that the chemical bodies which aid fertilization offer no assistance to bastardation.

Polyspermy can be brought about by chemical, thermal, and mechanical agencies, and the number of spermatozoa increases with the intensity and duration of the agents used; with heating, however, there is a point at which fertilization stops.

Two hypotheses suggest themselves as explaining how polyspermy is ordinarily prevented; one is that the fertilizing spermatozoon causes a contraction of the egg-cell, which prevents the entrance of other spermatozoa: and the other is that the spermatozoon stimulates the ovum to produce a firm membrane—the vitelline—through which other spermatozoa cannot make their way. The former of these may be dismissed now that we know that polyspermy may be aided by reagents which increase the contractility of the egg; the latter has the support of Fol, and seems to find support from some experiments made by the writers. If ova be placed in seawater with which chloroform has been shaken up, the membrane appears

exactly as it does after fertilization, and such ova cannot be fertilized by spermatozoa.

In investigating this matter a little further it is necessary to distinguish the two peculiarities of protoplasm which are exhibited in the formation of the yolk-membrane; these are its secretory activity and its irritability. The egg must have a minimum stimulus to produce its membrane, and this minimum stimulus is, in normal eggs, the entrance of one spermatozoon.

We now pass to the changes in the conjugation of the sexual nuclei and the internal processes of fertilization. The experiments which have been made show that, with the aid of reagents, the copulation of the nuclei may be hindered or stopped. It seems to be certain that nuclei provided with all the vital properties which are necessary for further development only appear when the substances are thoroughly impregnated by the male and female nuclei; however, even when the nuclei do not unite, they have properties which they had not originally; the male and female nucleus are both capable of undergoing fibrous differentiation and forming chromatic loops and a chromatic filament, even if they are kept separate from one another. If portions of ova without nuclei are separated from the rest of their cell, they may be penetrated by spermatozoa which in them form spindles; or, in more general terms, we may say that the protoplasm of the egg alone is able to give the male nucleus the power of forming spindles.

In ova, however, which possess germinal vesicles, the spermatozoa undergo no changes and are not acted upon by the protoplasm of the egg; if the directive spindle is in the process of formation the heads of the spermatozoa remain unaltered, but there is a slight radiation of the protoplasm. No exchange of substance takes place between the male nucleus and the ovarian protoplasm until after the formation of the first directive corpuscle.

In observing the fate of the female nucleus the authors found three classes of results: the ovarian nucleus copulates with only one male nucleus, and in division only one spindle is formed; the ovarian nucleus copulates with two or more male nuclei, and produces four-poled or many-poled karyokinetic figures; or the ovarian nucleus remains by itself, and by the imbibition of fluid increases rapidly in size. The last phenomenon is common in proportion to the number of spermatozoa that enter the egg.

Two or three male nuclei may certainly fuse with the female nucleus, so that the capacity of the female nucleus for receiving spermatogenic nuclei appears to be considerable, and to last even after several copulations have taken place. The male nuclei undergo fibrous differentiation, and become converted into small spindles, which in course of time also divide; nothing, however, is yet known as to the fate of these products of division.

The last point to be noticed concerns the variations in the phenomena of cleavage. In their experiments, the Drs. Hertwig altered the process of cleavage in three ways; the eggs, after fertilization, were treated with reagents, or they were fertilized by several spermatozoa, or the completion of fertilization was hindered. In the normal stages of cleavage two processes go on simultaneously in the nucleus; one is an increase in size, and the other is karyokinesis. The latter, but not the former, is affected by quinine and chloral; similar changes may be seen in polyspermy. When this last is brought about by the aid of morphia, strychnine, or nicotine, or, in other words, by reagents which do not of themselves influence the process of division, there appear tetraster or polyaster figures, which are to be explained not by the action of the reagents, but by polyspermy. There can be no doubt that fertilization by two spermatozoa leads to the formation of tetrasters; but all tetrasters must not be referred to this cause, as

the result may be sometimes due to nothing else than a certain increase in the size of the nucleus. The authors have made numerous observations with especial reference to the formation of double monsters, and they see no reason to suppose that these are to be regarded as due to the fertilization of one egg by two spermatozoa.

Human Ovum.*—Dr. W. Nagel communicates a description of the human ovum, in regard to which there has been a lack of precise information. His material was obtained from ovaries removed in operations. Healthy follicles were isolated and examined, and in other cases sectioned *in situ*.

The zona pellucida is very distinct, and is separated by an extremely fine "perivitelline space" (apparently containing clear fluid) from the vitellus. Within this is the narrow clear "cortical layer" of the vitellus, then a somewhat broader finely granular "protoplasmic zone," then the "deutoplasmic portion" with abundant globules, more abundant and less refractive than in the ova of domestic mammals.

The nucleus is round, clear, double-contoured, always excentric, and in the protoplasmic zone. There is a distinct nuclear network. The nucleolus exhibits amoeboid movements.

The corona (epithelium of ovum) was always well developed on ripe eggs. The diameter of the ripe ova varied from 124–128 μ . The various zones vary somewhat in different regions. The nucleus measured 19–20 μ .

In the ovaries of new-born subjects, besides the usual primordial follicles, larger follicles were observed (Waldeyer-Slavjansky). In these, sections revealed normal ova, and the author does not therefore regard the presence of these large follicles as indicative of incipient cyst-formation.

In development, the protoplasm and nucleus increase in size, the follicular cells multiply, the deutoplasm is formed, the nucleus is pushed to the side, and a zona pellucida begins to appear.

Fertilization of Ovum of Lamprey.†—Herr A. A. Böhm has studied the phenomena of fertilization in the ovum of *Petromyzon planeri*, and gives the following summary of his results:—

(1) The substance of the germinal vesicles spreads out on the surface of the ovum at the animal pole to form the pole-plasma.

(2) During impregnation, *pari passu* with the formation of the vitelline membrane, the pole plasma is covered with a fresh, thick, folded membrane. This concentrates the fertilization to a limited area, and disappears after fertilization is accomplished.

(3) The pole-plasma with the elements concerned in fertilization is retracted inwards, but remains connected with the surface of a thin protoplasmic strand which lies in the axis of the ovum in the plane of the first meridional segmentation.

(4) The male and female nuclei fall into portions (spermato- and karyomerites).

(5) For a while these can be microchemically distinguished.

(6) The merites do not at first intermingle, but form two closely apposed groups. The plane separating these two groups coincides with a meridian of the ovum.

(7) Each merite consists of a body with little chromatin and a body rich in chromatin (the microsomes).

(8) The final nucleus of segmentation arises by the fusion of the

* SB. K. Preuss. Akad. Berlin, 1887, pp. 759–61.

† SB. Bayer. Akad. Wiss. München, 1887, pp. 53–62.

spermato- and karyo-merites into a homogeneous mass. The included microsomata are no longer distinguishable as regards their origin.

(9) From these microsomata the chromatic portion of the karyokinetic figure is formed.

Intra-Ovarian Egg of some Osseous Fishes.*—Dr. R. Scharff has examined the ova or ovaries of several osseous fishes, among which the gurnard was a very suitable object of investigation. In speaking of the nucleus and its changes in the smaller ova, the author announces his agreement with the opinion of Dr. Will, that no morphological significance is to be attached to the nucleoli; they must be regarded as large masses of chromatic substance. With regard to the dark and light-coloured protoplasm, it is suggested that the dark central protoplasm owes its origin to the nucleus. The egg-membrane, or more or less thick layer which surrounds the egg, and which has been called by seven different names, of which "zona radiata" is here preferred, is, in the gurnard, often granular; within is a much broader layer, which, by its semifluid condition, may be distinguished from the much firmer or elastic zona radiata. In the ripe ova the zonoid layer entirely disappears.

The follicular layer of the ripe gurnard's egg consists of a layer of closely set cells. With regard to its development, the author's observations are incomplete, but he is inclined to think that it owes its origin to the connective tissue; at any rate it is formed before an egg-membrane can be seen.

Development of Osseous Fishes.†—In his first chapter Dr. J. H. List deals with the morphological results which he has obtained by the study of the Labridæ, a family which is well represented in the Adriatic.

The ripe ovum of *Crenilabrus tinca*, before fertilization, has a diameter of about 0.9 mm.; the zona pellucida has an interesting structure, for it consists of two layers. Of these, the outer is formed of regular six-sided prisms, and the inner, which is more homogeneous, exhibits merely a feeble parallel striation. The germinal substance is only incompletely differentiated from the yolk in *C. tinca*, but in *C. pavo* it forms a clearer layer round the yolk. On the whole, the arrangement of the germinal substance in the ovum of *Crenilabrus* exhibits a close resemblance to that of the herring, as described by Prof. Kupffer; there are no signs of any germinal processes extending into the yolk.

The spermatozoa of *C. pavo* are 18μ long, of which the tail is 14μ ; at the moment when the spermatozoon is swallowed by the micropylar canal the inner part of the latter is blocked by a feebly refractive mass, and by this means the entrance of other spermatozoa is prevented. Seven minutes after the entrance of the spermatozoa into the egg the directive corpuscle was seen projecting from the funnel-shaped entrance of the micropyle, and within half an hour was extruded. The ovarian contents next underwent contraction, and within three-quarters of an hour after impregnation a clear space could be noticed between the zona pellucida and the contents; this space was filled by a colourless fluid, which was probably partly squeezed out from the yolk. The contraction of the germinal substance ceases after about an hour and a half; and the first segmentation groove appears. This is somewhat excentric. Almost simultaneously an equatorial groove appears at right angles to the first. From the next series of changes it became clear that the form of the nutrient yolk is dependent on the direction of the

* Quart. Journ. Micr. Sci., xxviii. (1887) pp. 53-74 (1 pl.).

† Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 595-645 (3 pls.).

greatest growth-energy in the germinal substance; this energy seems to depend on the direction of the planes of segmentation.

Six hours after impregnation the blastodisc is formed, and lies flattened on the now completely spherical yolk; its outer surface is bounded by a layer of flattened cells. Seven hours and a quarter after impregnation nuclei appear in the part of the intermediate layer which is visible around the margin of the blastodisc; these group themselves in almost concentric rows round this margin, and the rows are arranged in such a way that an interspace of the succeeding row corresponds to every nucleus. After pointing out the views held by previous writers with regard to these bodies, the author states that he himself has observed clear vesicular nuclei appearing round the edge of the blastodisc, and has found that they were derived from the nuclei of its marginal cells. Nuclear figures were never observed, but the author distinctly saw these nuclei constricted off from those of the marginal cells; the newly-formed structures increase in size rapidly, and soon become disposed in rows. As to the significance of the periblast the author hesitates to form a judgment, but the view that we have to do with a conversion into nutrient material does not recommend itself to him.

In his second chapter the author deals with the formation of the embryo, and compares his results with those of other embryologists who have studied the development of fishes; in the third chapter the development of the eyes and ears, of the central nervous system and notochord, of the intestinal tract and other parts of the body is described.

Polar Bodies and Theory of Heredity.*—Prof. A. Weismann publishes a confirmation and *résumé* of his previous conclusions which have been embodied in various papers since 1881. He regards it as a firmly established and fundamental fact that all animal eggs which demand fertilization give off two polar bodies as preparation for embryonic development, while parthenogenetic eggs never extrude more than one. This fact, he says, dismisses any merely morphological explanation of the precedents. If it had no physiological signification, parthenogenetic eggs could retain the portion of nucleus separated by a second division, no better than those which demand fertilization.

Dr. Weismann's opinion is as follows:—The first polar body represents the extrusion, after maturity is reached, of the too active protoplasm of the nucleus; the second is the extrusion of part of the germ-plasm itself, through which the quantity of original protoplasm from the parent is reduced by one-half. A similar reduction must take place in the male germinal cell, but it is impossible as yet to show this definitely from the observed histology of spermatogenesis.

Parthenogenesis occurs when the whole of the germ-plasm from the parent is retained within the egg-cell. Sexual reproduction demands that half the germ-plasm be extruded from the egg, so that the remaining half may again reach the required size by uniting with the sperm-nucleus.

In both cases the beginning of development depends on the presence of a certain, and indeed of the same quantity of germ-plasm. The fertilized egg gains this by the addition of the sperm-nucleus, and the commencement of embryonic change follows right on the heels of fertilization. The parthenogenetic egg contains from the first the necessary amount of germ-plasm, and it becomes active as soon as the extrusion of the single polar body has freed the egg from the "oogenetic" nuclear plasm.

* Weismann, A., 'Ueber die Richtungskörper, und über ihre Bedeutung für die Vererbung,' 1887.

In regard to the theory of heredity, Dr. Weismann concludes that the germinal cells of a single individual do not embody similar hereditary tendencies, but that in this relation they are all different, and that no two provide quite the same combination of tendencies. This he thinks explains the long-recognized differences between the children of the same father and mother; and he adds that the deeper import of this arrangement must be seen in freely-conditioned ever-newly-blending individual variability, for sexual reproduction appears more and more in the light of an arrangement by which an ever-changing wealth of individual conformations is handed on.

B. Histology.*

Theory of Cell-division.†—Herr G. Platner has been led by the results of his study of karyokinesis in Lepidoptera to seek to lay the foundations at least of a theory of cell-division. He has tackled the problem of cellular mechanics, and finds the condition of nuclear division to be in part at least streaming of the protoplasm, such as is familiar in pseudopodia and Myxomycetes. The phenomena of karyokinesis can be explained as the results either (1) of chemical processes influencing the cellular substance, or (2) of protoplasmic movements due to the above or to external influences, or (3) of unknown molecular and attractive forces.

According to Platner, the separation of the daughter elements on the dislocation of the equatorial plate (Flemming's metakinesis) is the result of a circulating stream. The form and position of the nuclear spindle are mechanically conditioned by fluid movements within the latter, and radiating from the poles. The appearance of the primary asters depends upon the direction in which the stream of nutritive fluid circulates through the cell, and the spindle develops at right angles to this. The same causes effect the movements of the nucleus. The formation of the nuclear coil, and the disposition of the equatorial plate is the result of plasmic streams penetrating the nucleus in given direction. The achromatic substance is the active element in karyokinesis. The division of the protoplasm is a purely mechanical process.

Synthetic Processes in Living Cells.‡—Fräulein J. Brinck and Herr H. Kronecker submit the results of numerous observations on the physiological relations between living cells and various substances. Their experiments led to the following conclusions:—(1) Serum-albumin is more surely characterized by its nutritive relation to muscle, than by physical and chemical reactions; (2) stomachic peptones are still albuminoids in the physiological sense, pancreatic peptones are not; (3) Stomachic peptones are reconverted into serum-albumin by many kinds of living cells; (4) a bacillus has the same useful property of forming serum-albumin from stomachic peptones; (5) pathogenic bacilli have a destructive influence.

Structure and Distribution of Striped and Unstriped Muscle in the Animal Kingdom.§—Mr. C. F. Marshall has endeavoured to trace the distribution of the intracellular network of the striped muscle-fibre in the animal kingdom. It is pointed out that the striation of muscle must not be confounded with the transversely striated appearance which is caused by the corrugation of the outline of the fibre, and which is probably due to a state of over-contraction.

* This section is limited to papers relating to Cells and Fibres.

† Internat. Monatschrift f. Anat. u. Histol., iii. (1886) p. 10. Naturforscher, xx. (1887) p. 315.

‡ Archiv. f. Anat. u. Physiol., 1887, pp. 347-9.

§ Quart. Journ. Micr. Sci., xxviii. (1887) pp. 75-107 (1 pl.).

The vacuolated condition seen in the protoplasm of various Protozoa may, perhaps, indicate the starting-point of the differentiation of an intracellular network, or, in other words, the differentiation of the cell into firmer and less dense portions, the former of which takes on the form of a network; the highly contractile fibril of *Vorticella* shows no trace of the presence of fibrils, and appears to be simply undifferentiated protoplasm.

Of the Coelenterata *Hydra* was found to have a network in the body of the ectoderm cells, but this was not continued into the "muscular process"; *Aurelia* has striped muscles in which the distinct transverse striation is due to the presence of a network which is similar in all respects to the network described by Retzius and Melland in striped muscle; in *Actinia* the muscle showed no trace of any intracellular network or of any fibrillation. Here, then, as with the Echinodermata, in which there is no trace of a network, the author agrees with Dr. Hamann.

Among worms, the leech and the earthworm were examined; in the former the muscle-fibres are very peculiar, consisting of an outer clear portion and a central granular part; no distinct fibrils could be detected. In the earthworm the muscle is found to contain large elongated cells with longitudinal lines, which under a 1/10 immersion objective present a dotted appearance; the dots, however, are quite irregular, and do not extend into the body of the cell.

In the Mollusca, the limpet was found to have the network of striped muscle in its muscle, and the same was found in the muscle of the snail's odontophore, and in the adductor muscle of *Pecten*, which differs from most of its class by using that muscle to propel itself through the water. Striped muscle was found in various Arthropods, and in the muscular bands of *Salpa*.

As to the Vertebrata, it is to be noted that the striation of cardiac muscle appears to be due to an intracellular network similar to that of ordinary striped muscle.

If we resume these facts, we find that striped muscle is ordinarily associated with energetic animals or movements; the presence of such in some sluggish animals, such as certain insects, may be supposed to be due to inheritance. We find that (1) an intracellular network of a definite character is present in the fibre of striped muscle throughout the animal kingdom. (2) This network is developed where rapid and frequent movements have to be performed. (3) The striped muscle-fibre consists of sarcolemma, network, and sarcous substance; and, so far as at present determined, there is no other structure present in the fibre (except muscle-corpuscles and nerve-endings). With regard to the mode of action of striped muscular fibre, Mr. Marshall is of opinion that its construction is due to the active contraction of the longitudinal bars of the network, and that the transverse networks are probably passively elastic, and cause by their rebound relaxation of the fibre. It is possible that the transverse networks and the muscle-corpuscles with which they are said to be continuous, furnish paths by which the nervous impulse is conveyed from the nerve-ending to the longitudinal bars. As to the contraction of unstriped muscle, it is probably due to the active contraction of its longitudinal fibrils, when such, as in vertebrate muscle, are present; when they are absent the contraction must be referred to the whole protoplasm of the cell, for there is no special part differentiated to perform the function.

The author is aware of two objections to his suggested explanation; the first affects the supposed difference between the longitudinal and transverse bars of the same network; but it is possible that the latter are really, as Retzius thinks, direct processes of the muscle-corpuscles. The

second objection is that the theory attributes the function of contraction to the network which forms much less of the bulk of the fibre than does the sarcoous substance; but the latter may have to perform thermogenic functions which must absorb a far greater amount of its energy than does the contractile function.

Comparative Size of Blood-corpuscles in Man and Domestic Animals.*

—Miss F. Detmers considers that she has established, by a series of measurements, that there can be no question but that the blood of human beings can readily be distinguished from that of such animals as the mule, cat, calf, and horse, and more readily from cattle, sheep, and pigs.

Blood-corpuscles of the Cyclostomata.†—Prof. D'Arcy W. Thompson traverses the generalization found in many text-books that the red blood-corpuscles of Cyclostomata are round and not oval. He finds, as indeed did J. Müller, that the red corpuscles of *Myxine* are large and oval, being $\cdot 025$ – $\cdot 028$ mm. in length, about $\cdot 01$ mm. in breadth, and about $\cdot 003$ mm. in thickness. In *Petromyzon marinus*, the red blood-corpuscles are circular, and about $\cdot 013$ to $\cdot 014$ mm. in diameter, and the nuclei are excentric and stain very slowly and feebly with magenta, whereas in *Myxine* they are central and stain easily. Shipley, who has recently stated that the red corpuscles of the ammocete are oval, confirms his statement; this noteworthy difference between the larval and adult forms recalls the differences in the red corpuscles of the tadpole and the frog.

The white blood-corpuscles of *Myxine* are nearly or sometimes quite as numerous as the red, are of about the same size as in man, and have a very large granular nucleus. In *P. marinus* they are three or four times as numerous as the red, their nuclei are small and stain well; forms transitional in shape and size to the red corpuscles may be recognized.

Hæmatocytes.‡—M. Fokker gives a somewhat astounding account of some observations on the behaviour of blood. He has previously sought to show that protoplasm from a healthy organism, placed in a nutritive medium, with the exclusion of microbes, may remain alive and cause fermentations. He now seeks to prove that such protoplasm may develope a vegetative form, different from that exhibited in the body of the animal from which it was taken.

Some blood was taken with all necessary precautions from a healthy animal, placed in distilled sterilized water, and kept at the ordinary temperature, and at 37° C. It remained alive, but above 37° died.

If the distilled water be replaced by a very weak solution of nutritive salts, or even by drinking water, the blood remains at the ordinary temperature alive, for a year even. But at 37° , and above, a sediment is formed. The amorphous molecules in the debris increase gradually and form small vesicles which may attain the dimensions of the blood-corpuscles! These little knobs M. Fokker calls hæmatocytes, and the process is designated heterogenesis. These vesicles have nothing in common with any elements previously described in the blood. They may be stained with iodine, or with methyl-violet, fuchsine, and eosin. They have often a regular form, and their size is very variable. They do not multiply in cultures.

That they are really alive is demonstrated by their growth as observed under the Microscope, and by the fact that they do not develope in the absence of oxygen.

* St. Louis Med. and Surg. Journ., liii. (1887) pp. 209–15.

† Ann. and Mag. Nat. Hist., xx. (1887) pp. 231–3.

‡ Comptes Rendus, cv. (1887) pp. 353–6.

He kept dilutions of blood in drinking water at the ordinary temperature, and others in saline solution at 37°. At the end of a year in the one case, and of three months in the other, he placed the dilutions in a temperature of 52°. By the end of 24 hours both dilutions had gone in for almost normal heterogenesis.

γ. General.*

Phosphorescence.†—On this subject, Dr. C. F. W. Krukenberg reviews the literature up to the present time, referring to Ehrenberg, Milne-Edwards, Panceri, Pflüger, and other investigators. He then gives in detail, and at considerable length, the results of his own recent experiments and observations in three special directions. The first and second of these are the cases of *Pteroides griseum*, and *Agaricus (Crepidotus) olearius*. The third deals with the luminosity of the Red Sea, and includes some very graphic descriptions of phenomena observed. The experiments, which are described at length and also given together in tabular form, consisted principally in watching the light-producing organisms in very widely varied circumstances as to medium and temperature, and also in treating them with various anæsthetics and other chemical reagents.

Dr. Krukenberg emphasizes as the most general and important conclusion from the investigations, and that likely to afford most guidance in future research, that, in both animals and plants, whenever phosphorescence is truly present, it is caused by certain vital processes being applied to the production of light in a manner exactly parallel to those in which heat and electricity are produced in living beings.

Function of Otoliths.‡—Prof. T. W. Engelmann made some observations on the functions of the so-called otoliths in the sensory bodies of Ctenophores previous to the appearance of Dr. Delage's paper. He thinks what he has seen confirms the views of the French naturalist, and hopes that the investigation will be carried further. The author regards the so-called otoliths which are placed at the aboral pole of the body of Ctenophores as an apparatus for preserving the equilibrium of the body. After a reference to the discoveries of Chun, he concludes that there is no reason for adhering to the old view that the bodies in question have any auditory function, and he thinks it clear that the object of the otolith is, by means of the ctenophoral plates, to keep the primary axis of the body in its normal upright position. When this axis is vertical, the otolith presses with equal force on the four pinnate bands which extend up to it; if the axis inclines at all it presses more strongly on the corresponding band, and less on the others. This pressure is, by means of the cellular cords connected with the band, which are nervous in function, conveyed to the ctenophoral plates, and thus a compensating movement of the body is brought about, and the body returns to its normal vertical condition. We have here a reflex process of the most elementary kind—a process of regulation in which it is not necessary for either conscious sensation or will to take any part, but which may be altogether mechanical.

Reference is made to a number of illustrative and instructive facts, such as the very general presence of otoliths in freely moving animals, their absence in many fixed or slowly creeping forms, and their loss in fixed forms which have large otoliths in their freely moving early stages; in many cases (Mollusca) they are imbedded in soft inelastic tissue which

* This section is limited to papers which, while relating to Vertebrata, have a direct or indirect bearing on Invertebrata also.

† Vergleichend-physiologische Studien, iv. (1887) pp. 77-142.

‡ Zool. Anzeig., x. (1887) pp. 439-441.

is by no means adapted to carrying waves of sound; they are very generally connected with cellular outgrowths which are necessarily pressed upon when the equilibrium of the body is disturbed. These considerations may be extended to the Vertebrata, and it is suggested that the cristæ acousticæ of the ear with which no otoliths are connected may perform the acoustic functions of the ear, while the maculæ acousticæ have an equilibrating function. The well-known observation of Hensen as to the casting of the otoliths in certain Crustacea seems to be of great significance in connection with the real function of these organs.

B. INVERTEBRATA.

Pericardial Gland of Opisthobranchs and Annelids.*—Prof. C. Grobben endeavours to demonstrate the homology of the pericardial gland of Molluscs with structures which are found in Annelids. He points out that the pericardial gland of Molluscs is a local glandular development of the epithelium of the secondary cœlom, as the pericardial space must be regarded as being.

Similar glandular differentiations of the cœlomic epithelium are to be seen in the chlorogogue cells of many Annelids, and they too are found on the blood-vessels. In some cases these bodies form special organs; they are best developed in the well-known tubular contractile appendages of the dorsal vessel of the Lumbriculidæ, and the structures described by Claparède in *Lumbricus* as best developed on the vascular loops of the septa are bodies of the same kind. The excretory function of the pericardial gland and epithelium is best shown in the Mollusca; these are cells heavily laden with concretions which can hardly make their way to the exterior save by the kidney; similar bodies escape outwards by the nephridia in Annelids.

Singular Parasite on *Firola*.†—Prof. H. Ludwig has a note on the remarkable parasite in *Firola* (*Trichoelina paradoxa*), lately described by Dr. J. Barrois,‡ showing that it is nothing more than the separate capitulum of a gemmæform pedicellaria, and almost certainly of *Sphærechinus granularis*.§

Mollusca.

Structure of Branchia of Prosobranchiate Gastropoda.||—M. F. Bernard has investigated the structure of the gill of various prosobranchiate gastropods. He finds that the epithelium always consists of two kinds of elements—columnar ciliated cells, inserted on a basilar membrane by a narrow prolongation which is sometimes branched, and muciparous cells arranged in small scattered groups. The basilar membrane does not contain any cartilage; what has been regarded as such is a thickening formed of superposed layers, and contains no trace of cells. Between the two layers of the membrane are stellate cells, with anastomosing prolongations; these, which may be isolated or connected, form the ordinary connective tissue of the lacunæ. There are longitudinal and transverse muscular fibres.

Although the author has been able to reproduce the appearances figured recently by M. Wegmann, he does not believe that the “vessels” are anything more than portions of the lacunæ where the connective tissue is scattered, and where therefore the injection circulates easily. The space contained by the double basilar membrane is only a simple diverticulum of the general lacuna which extends between the two folds of the mantle.

* Zool. Anzeig., x. (1887) pp. 479–81.

† Ibid., pp. 296–8.

‡ See this Journal, ante, p. 373.

§ This note, owing to a misprint, was wrongly placed at p. 598, and *Trichedina* was printed for *Trichoelina*.

|| Comptes Rendus, cv. (1887) pp. 316–8.

Structure of False Gills of Pectinibranch Prosobranchs.*—M. F. Bernard has examined the so-called false gills in *Cassis*, *Buccinum*, *Nassa*, *Murex*, and various other genera of pectinibranch gastropods. He thinks we must consider the organ as formed of a series of folds of the internal layer of the mantle. The space in the interior of each lamella is a lacuna which communicates by a cleft with the large intrapallial lacuna which extends under the false gill. The afferent branchial canal which extends between this organ and the true gill is well provided with muscular walls on the side of the latter; but on the side of the false gill it is only separated from the intrapallial lacuna by a spongy connective tissue perforated by a large number of orifices by which the blood of the false gill passes to the canal and thence to the heart; the canal is not therefore strictly a vessel.

A principal nerve, sometimes formed of several anastomosing bundles, penetrates into each lamella where it gives off ramifications; among these are found multipolar connective cells identical with those found in the true gills. The nerve has been easily studied by the aid of the double chloride of ruthenium and potassium (or ammonium), which was found to be more useful than hyperruthenic acid. By its means the fibres may be seen to become gradually isolated and to terminate in large rods placed among epithelial cells.

The epithelium contains mucous cells, ciliated cells as in the gill, and elements which end in a pretty long delicate rod. The basilar membrane presents crests, folds, and thickenings directed along the courses of the nervous ramifications, but there are never the double longitudinal thickenings which are characteristic of the branchial lamellæ.

The muscular fibres are numerous and varied, and may, by their combination, diminish the size of the blood-sinus, but their irregular arrangement, and the presence of connective elements in the interior of the sinus prevent our regarding the latter as a vessel. In some Strombidae and in *Pterocera*, the nerve bifurcates several times and branches in a fanlike fashion. On the whole, the author regards the false gill as a sensory organ formed by folds of the mantle in which there are a number of nerve formations. In some of the higher forms the connective elements are so arranged as to form a respiratory apparatus no less differentiated than the gill-lamellæ themselves.

Renal Organs of German Prosobranchiata.†—Herr G. Wolff has investigated the structure of the renal organs of *Paludina vivipara*, *Bithynia tentaculata*, and *Valvata piscinalis*. He has been able to detect the internal orifice of the organ, though it is considerably degenerate. The ductus renopericardialis appears to be least atrophied in *Valvata*, which so far stands nearest to the pulmonate gastropods; the well-developed cilia found on its epithelial cells are wanting from *Paludina* and *Bithynia*. In *P. vivipara* the duct is placed at the point where the renal organ opens into what Leydig called the water-reservoir, and it is clear that the pericardial orifice of the kidney is physiologically connected with the opening of the kidney into the reservoir, since the muscular fibres which surround it are connected with the sphincter which surrounds the other opening of the kidney. The glandular organ of *Bithynia* has two openings which lead to the exterior, one superior, and one inferior. The pericardial orifice is placed near the upper of these.

Oogenesis of Chiton.‡—M. P. Garnault has studied the development of the ovum and its follicle in *Chiton cinereus* and *Chiton fascicularis*, and

* Comptes Rendus, cv. (1887) pp. 383-5.

† Zool. Anzeig., x. (1887) p. 317.

‡ Comptes Rendus, cv. (1887) pp. 621-3.

has been led to results somewhat different from those of Ihering and Sabatier.

According to Sabatier, the ova are formed at the expense of the connective cells of the ovarian wall. As they grow they raise the connective padding (feutrage) which surrounds them. They are covered by a non-cellular membrane. Nuclei arise within the protoplasm and shift to the periphery.

M. Garnault maintains that the ova arise from a germinal epithelium, that the follicle consists distinctly of cells homologous with those which form ova. The internal corpuscles said to move to the periphery are not really nuclear, but only intra-vitelline, albuminoid bodies.

The stalked ovum exhibits on its surface and in relation to each of the follicular cells, protrusions of the vitellus, especially marked in *C. cinereus*. The summit of each vitelline expansion is in close association with the nucleus of the follicular cell. Soon these protrusions retract, dragging with them the nucleated portions of the several follicular cells. The stalk degenerates, and before the final rupture is represented only by a membranous shred. The point of rupture corresponds to the micropylar orifice. The follicular membrane becomes thickened and depressed; it ought not to be spoken of as *coque* or *chorion*. The final non-cellular membrane, described by Sabatier, does not exist.

Nephridia and "Liver" of *Patella vulgata*.*—Dr. A. B. Griffiths has made a chemical examination of the nephridia of the common limpet, and has been able to isolate uric acid, and to obtain successfully the "murexide test." He finds that, with regard to the "liver," its secretion converts starch into glucose-sugar, as proved by the use of Fehling's solution; the secretion produces an emulsion with oils and fats, yielding subsequently fatty acids and glycerol; when a few drops of the secretion were examined with chemical reagents under the Microscope a brown deposit was obtained with a solution of iodine in potassium iodide; with concentrated nitric acid there was a yellow coloration, due to the formation of xantho-proteic acid; both these reactions show the presence of albumin in the secretion of this organ.

On the soluble ferment being isolated by the method of Wittich and Kistiakowsky it was found to convert fibrin into leucin and tyrosin, no glycocholic or taurocholic acid could be detected, and no glycogen was found in the organ or its secretion; but this secretion does contain leucin and tyrosin. The author concludes, therefore, that the "liver" of the limpet has a similar function to the pancreas of the Vertebrata.

Morphology of Epipodium of Rhipidoglossate Gastropoda.†—M. P. Pelseneer, in consideration of the very various opinions that have been held as to the morphology of the epipodium in rhipidoglossate Gastropods, has reinvestigated the anatomy of *Trochus*. He finds that in it each pedal cord has an external longitudinal groove, but it is, nevertheless, not composed of two nerves, the peculiar conformation being due not to the fusion of two different centres, but to the commencing separation of a single one; this specialization is due to the development of the epipodium. The pleural ganglion lies at the commencement of the pedal cord, where the visceral commissure commences to be formed. M. Pelseneer finds, therefore, that the pedal cord of *Trochus* is single, and that the epipodium is a part of the foot; it would, indeed, be hard to conclude otherwise, when we examine a *Trochus* externally, for it may then be seen that the epipodium has no

* Proc. Roy. Soc. Lond., xlii. (1887) pp. 392-4.

† Comptes Rendus, cv. (1887) pp. 578-80.

relation to the mantle, but is placed quite beneath the foot, and surrounds the operculum, as to the pedal nature of which there is no doubt.

Byssus Gland of Lamellibranchs.*—Herr L. Reichel is of opinion that the byssus of Lamellibranchs is a cuticular structure, the roots of which are formed in the byssus-cavity, and the filaments in the groove of the foot. The glandular cells which should be present, were the secretion-theory correct, are never to be found. The groove can, by the approximation of its edges, be converted into a complete canal, the lumen of which is semilunar in shape. The epithelium of the canal and of the cleft continuous with it are distinguished by two characters: in the latter the cilia are placed on a cell-membrane, which, in cross-section, has a distinctly double contour; in the former there is but a single line between the byssus-substance and the epithelial cells; each cell of the canal has only one process, while those of the cleft have each several cilia. Other objections are raised to the secretion-theory.

New Sensory Organ in Lamellibranchiata.†—Dr. J. Thiele has examined the two yellow papillæ found near the anal papillæ in *Arca Noæ*. He finds that they are closely covered by long immobile hairs, and that in transverse sections their epithelium has a striking resemblance to that of the lateral organ of the abdomen, described by Eisig in the Capitellidæ. Internally there is a considerable layer of granules, among which is a network of processes, and thin spindles and rods. The author proposes to call these bodies abdominal sensory organs. They are supplied by a nerve which branches off from the most median of the nerves which extend backwards from the visceral ganglia; beneath the organ is a small ganglion, whence the separate nerve-fibres pass to the sensory cells.

Similar sensory spheres have been found not only in the closely allied *Pectunculus*, but in Aviculidæ, Pectinidæ, and Ostræidæ; they are distinguished from Eisig's organs by their want of retractility, but this may be explained by their protected position in the mantle space. The author has not yet been able to find these organs in siphoniate Lamellibranchs, but the specimens examined were not very satisfactorily preserved.

Molluscoida.

a. Tunicata.

Observations on Ascidians.‡—Miss L. Sheldon commences with a note on the ciliated pit of Ascidians in its relation to the nerve-ganglion and so-called hypophysial gland. In the adult forms examined four main variations of the pit were observed; in *Clavellina* it is simple in shape, its opening into the mouth being round in section; it is situated ventrally to the nerve-ganglion into which it leads by a wide opening; in *Amarœcium* the pit is shorter and simpler, and has no connection with the ganglion; the mass of spongy tissue into which it opens appears to be degenerated, and somewhat resembles the notochordal tissue of vertebrate embryos. In *Ascidia* and *Ciona* the pit consists of a ciliated funnel passing into a canal; and in *Phallusia mammillata* there is a large reservoir lying ventrally to the ganglion which communicates with the mouth by a comparatively small orifice.

In the embryo of *Amarœcium* the nervous system consists of four portions; an anterior dorsal part which exactly resembles in structure the ganglion

* Zool. Anzeig., x. (1887) pp. 489-90.

† Ibid., pp. 413-4.

‡ Quart. Journ. Micr. Sci., xxviii. (1887) pp. 131-48 (2 pls.).

of the adult, a mass which lies ventral and posterior to it, and is composed of very large ganglion-cells with very distinct nuclei and nerve-fibres; from the latter a nerve-cord passes off into the tail, and on one side of it there is a hollow sense-vesicle which has thin anterior and thick posterior walls; the unpaired eye is imbedded in the antero-dorsal angle of the wall, and the otolith is situated on its floor, and projects upwards into its cavity. This last is the only part of the nervous system which is hollow at this time. The ciliated pit opens into the solid nervous substance at about the middle point of the ventral surface of the first portion, and on the dorsal surface of the second.

As the ciliated pit of the embryo *Amarœcium* is connected exclusively with the brain, it seems probable that its original function was the aeration of the brain (compare the Nemertinea). In *Ascidia* and *Ciona*, and probably most other simple Ascidians, the function of the pit is that of a duct for the so-called hypophysial gland, while in *Clavellina* it communicates with the brain and probably aerates it, and also acts as a reservoir to carry off the secretion of the gland; or, in other words, has retained its primitive while taking on its secondary function. The pit is probably homologous with the hypophysis of vertebrates, in which the pineal gland possibly represents the dorsal continuation of the *ciliated pit*.

Some notes on the anatomy of *Cynthia* complete the paper.

Anatomy of Distaplia.*—M. F. Lahille describes the anatomy of the genus *Distaplia*, which has hitherto received but scant attention, though the form in question appears to be of some importance as a synthetic type.

There are 6 buccal, and 4 cloacal lobes, the latter forming a long tongue in the adult. Four rows of very long bars (trémas) are united medianly by transverse anastomosing vessels. The latter support the "inter-trematic" sinuses which much increase the respiratory surface. The transverse vessels, which in the high Phlebobranchs form what are called the ribs of second and third order, very rarely interrupt the bars in *Distaplia*. They are formed from the fusion of bifurcating papillæ which spring from the middle of each inter-trematic sinus. The transverse sinuses are in their disposition intermediate between that of the Diplosomiæ and that of the Aplidiæ.

The pericoronal groove (gouttière) is homologous with the vibratile arcs in *Appendicularias* and morphologically independent of the branchiæ in all Ascidians. Into it the vibratile oval organ opens, and two nerves occur on the base of the groove. The tentacles, at first two, then four in number, increase by the formation of four other pairs appearing on the neural side.

As in the Aplidiæ, the posterior portion of the branchia, to the side of the œsophagus, gives origin to the two endodermic tubes. These are, however, unequal and separate, do not involve heart or genital organs, and exhibit several muscle bundles and an ectodermic epithelium. They discharge the asexual multiplication, and correspond to stolon-tubes. Their marked development affects the other organs.

The intestinal gland is greatly developed, its ducts anastomose abundantly. It opens into a reservoir which communicates by a canal with the stomach. There is a cloacal diverticulum for incubation.

In all their characters the young forms are Diplosomidæ, and the Leptoclinidæ connect them with *Pyrosoma*. The adults are Distomidæ as regards the position of their viscera, but in general structure Aplidiæ.

* Bull. Soc. d'Hist. Nat. Toulouse, xxi. (1887) pp. 30-3.

Are the Tunicata degenerate Fishes?*—Prof. E. van Beneden discusses the arguments of Prof. A. Dohrn in favour of the degeneration of the Tunicate from fishes. He regards those arguments as based on the belief that the pseudobranchial grooves of the Cyclostomata are derived from a pair of branchial clefts, and that the rudiment of the thyroid of fishes, the hypobranchial organ of the Cyclostomata, the hypobranchial band of *Amphioxus*, and the endostyle of Tunicates, are the modified remains of another pair of branchial clefts. But the study of the innervation of the branchial apparatus of *Ammocoetes* shows that the first branchial cleft of the Cyclostomata is the homologue of the spiracle of Selachians, and the true branchial nerves of one have just the same disposition as those of the others. If its innervation is to be the criterion the thyroid body represents several segments.

In the answer which Prof. Dohrn has made to these criticisms he denies the statements of M. Julin as to the innervation of the branchial apparatus of *Ammocoetes*. Prof. van Beneden points out that the German naturalist has studied very small larvæ, whereas Julin examined such as had nearly completed their development. M. Julin is to investigate young forms in order to control the observations of Dohrn. In a further answer Dr. Dohrn refers merely to a slight criticism of Prof. Beneden.

Arthropoda.

Structure of Alimentary Canal.†—Prof. A. Schneider communicates a series of notes on the anatomy and histology of the alimentary canal of Arthropods.

(1) *The hypodermis* of insects consists, as Schneider and others have previously maintained, of a nucleated protoplasmic layer, without distinct cells, continuous with the sarcolemma and neurilemma of muscle and nerve, a literal ecto-mesoderm. Chitin is not an excreted substance, but a slow modification of the protoplasm. There is no real difference between that formed from muscle insertion, and that formed from the protoplasm.

(2) *Fore- and hind-gut* have the structure which one would expect in invaginations of the ectoderm,—internally a chitinous layer, not sharply defined from the outer homogeneous hypodermis, which is succeeded by a layer of transverse and longitudinal muscle-fibres, the sarcolemma of which is continuous with the hypodermis. The ridges of the hind-gut of caterpillars are formed from longitudinal muscle-fibres.

(3) *The mid-gut* exhibits (a) the cellular digestive and absorptive layer, (b) chitinous lamellæ, (c) hypodermis, and (d) muscle-fibres. The chitinous layer of this region is renewed like that of other parts during skin-casting. These results hold true of other Arthropods as well as insects, to which they principally refer.

(4) *Special structures.* (a) In many insects the hind-gut exhibits spinous modifications of the chitin. These are briefly referred to. (b) Similar chitinous thickenings in the fore-gut are much more frequent. Their disposition in various insects is simply noted.

(5) *Musculature of fore-gut.* The fibres are longitudinal and transverse, the latter occasionally radial. No notice has hitherto been taken of the occurrence of what may be called a "proboscis" (Rüssel). Posteriorly the fore-gut is in some cases evaginated forwards and outwards, projecting into the lumen of the mid-gut. This is associated with an alteration in the

* Zool. Anzeig., x. (1887) pp. 407-13, 433-6, and 582-3.

† Zool. Beitr. (Schneider), ii. (1887) pp. 82-96.

disposition of the muscle-fibres of the fore-gut. A second type of "proboscis" occurs in Hymenoptera, where a modification, originating as above, undergoes a second turning, the primary portion remaining undifferentiated and non-muscular.

(6) The memoir concludes with a description of the so-called funnel (Trichter), beginning at the end of the fore-gut. The first and commonest form arises on the outer surface of the proboscis, near its free end, in the form of a tube continuous with the chitinous layer, and extending on to the anus. A somewhat divergent modification occurs in ants, wasps, hornets, &c. In all cases it arises at first as a blind tube from the fore-gut. It appears to grow gradually by chitinous secretion at its anterior end, and to be dissolved posteriorly, passing out with the fæces. The common closed form protects the mid-gut from contact with hard substances. Its presence or absence, its closed or open form, depend on the nature of the food.

a. Insecta.

Spermatogenesis.*—Prof. v. la Valette St. George adds a fifth communication to his recent series of studies on spermatogenesis. He discusses the formation of the spermatocysts in Lepidoptera, and particularly the nature of the ensheathing membrane (Cystenhaut). What he long since stated, he still maintains, that the membrane arises from the apposition of individual cells. Recent observations have only confirmed his opinion. He also noticed the frequent occurrence of processes of various length and breadth arising from the membrane of the spermatocysts. The function of the "cystenhaut" is to inclose, separate, and bring to contemporaneous maturity its content of spermatocytes. Its rôle is fulfilled by other structures in other cases of spermatogenesis. The author notes the increasing adoption of his well-known nomenclature of spermatogenetic phases. The paper contains some lively criticism of recent investigations and investigators.

In concluding, Prof. v. la Valette St. George reiterates his classic law of spermatogenesis. The mother sperm-cells or *spermatogonia* (Stamensamenzellen, cellules de souche, &c., &c.), form by division an aggregate of cells—the spermatogemma—which in insects, as in Amphibia, acquires by the apposition of the peripheral cells a special sheath, and becomes a *spermatocyst* (Samenschlauch). The contents of this—the *spermatocytes* (Samenvermehrungszellen, cellules prolifératives, &c.), multiply by repeated division to form the immature sperms or *spermatides* (Samenausbildungszellen, &c.), from which finally the spermatozoa or *spermatosomata* result.

Tannin in Insects.†—Mr. Slater communicates the results of certain researches on the colours of insects. He considers that tannin, which is found in some leaf- and wood-eating species, may be the cause of certain of the yellow and yellowish-brown colours. Mr. Slater refers also to the experiments of M. Villou, who has extracted tannin from the corn-weevil. Black patterns Mr. Slater considers may be produced by the deposition of iron in the parts of the chitinous tissue, which readily takes up colouring matters when tannin is present. Similar lines and spots may be made to appear artificially by steeping the elytra in iron solution.

Histology of Enteric Canals of Insects.‡—Herr v. Faussek has discovered that in the mid-gut of *Eremobia* and the larva of *Æschna*, there are glandular crypts, formed by special cell-complexes, in addition to the

* Arch. f. Mikr. Anat., xxx. (1887) pp. 426-34 (1 pl.).

† Proc. Entomol. Soc. Lond., 1887, pp. 32-4.

‡ Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 694-712 (1 pl.).

cylindrical cells. In the cells of these glands, but not in those of the epithelium, mitotic division of the nucleus was observed. The rectum of *Eremobia* consists of two divisions which are separated from one another by a muscular valve; in both, the epithelial layer is well developed, and in that of the rectal glands there are mucous cells in addition to those of the ordinary cylindrical form. The rectum of the larva of *Æschna* also consists of two divisions, but these are not separated by any valve. Through its whole extent the epithelial cells are of two kinds, some being large with large nuclei, and the others small. The latter form compact folds, and the former either lie close to the muscular wall or give rise to simple folds widely separated from one another. In addition to its exterior gills, the rectum of these larvæ is provided with typical rectal glands.

Protective Value of Colour and Markings in Insects.*—Mr. E. B. Poulton has made a large series of experiments with the object of proving the protective value of colour and markings in insects in reference to their vertebrate enemies. He concludes that the extremely specialized defence of the larval stage follows from its delicate anatomical construction and the necessities which are imposed upon it as the great feeding stage. Highly conspicuous insects nearly always possess some unpleasant attribute, such as disagreeable taste or smell in the tissues and fluids of the body, irritating hairs, or stings, but in a small number of cases a conspicuous appearance has not yet been shown to be attended by any unpleasant attribute. In various species the same colours and patterns are again and again repeated, so that the vertebrate enemies are only compelled to learn a few types of appearance, and these types are of a kind which such enemies most easily learn. Certain appearances are especially impressed on them by highly aggressive insects, feared because of stings and so on; and hence, there is especial advantage in any approximation to such types. In a relatively few cases aggressive forms among the Vertebrata (serpents), are mimicked, though the insect itself is quite harmless.

Insects which are protectively coloured not uncommonly assume, when detected, a terrifying aspect, and in some cases take up offensive measures, such as the discharge of irritating fluid. A few forms, which are probably transitional, may be unconcealed, and yet not very conspicuous; these may possess unpleasant qualities, or may be eaten readily. As the likes and dislikes of insect-eaters are purely relative, and as, if pressed with hunger, they may eat the most disagreeable and highly conspicuous insects, we may here find an explanation of the fact that only a relatively small number of insects adopt such a means of defence. It seems probable that when one vertebrate eats an unpleasant insect and another refuses it, the former has conquered its prejudices, having originally disliked the insect.

In the sexually mature forms warning colours can be distinguished from sexual colours by their distribution on the surface of the body, by the way in which they are displayed in flight, by their type of pattern, and by the colours employed. The sexual colours or patterns are beautiful, the others conspicuous. This conspicuous appearance has relation to the injury which would be inflicted by the experimental "tasting" of certain enemies, such as birds or lizards; though enemies which, like frogs, inflict no injuries in tasting, have, to a limited extent, taken advantage of the warning colours.

Insects which evade their enemies by protective resemblance and attitude, by rapid movements or habits of concealment, are generally palatable, but they may possess an unpleasant taste or smell which may or may not protect them from their enemies; in a very small number of species the most perfect

* Proc. Zool. Soc. Lond., 1887, pp. 191-274.

form of protective resemblance may coexist with a most unpleasant taste. Mere size alone may protect a species against certain of its smaller foes. Comparing the different stages in Lepidoptera, unpleasant attributes appear to arise in the larval stage, and they then often pass through the two other stages attended or unattended, in one or both, by warning colours. The most highly specialized protective colours probably also possess value as sexual adornments.

Considerably more than one hundred species or stages of insects have been experimented on.

Lepidopterous Larvæ, &c.*—Mr. E. B. Poulton sums up the results of his observations during 1886 on Lepidopterous larvæ.

He shows that in the young conditions of *Smerinthus* and of *Sesia* there are characters present, many of which, though disappearing in later stages, serve to link together several of the allied genera.

Special reference is made to the red spots upon certain of the segments of *Smerinthus* which are considered as due to the modifications of a coloured border in ancestral forms. A new species of *Sphinx* larva from the Celebes with protective markings, as in *Chærocampa*, and with certain distinctly ancestral characters, is described. Interesting details are given as to the highly protective specialization which is met with among the Geometræ, in regard to their attitude and colour; and also as evident from the presence of certain otherwise useless processes on the body. Further mention is made of the defensive structures of the larva of *Dicrania* with their histological characters. Such defensive reversible glands must be considered as of fairly common occurrence, the *Lipariidæ* affording many examples. Further facts are noted with reference to the life-history of *Paniscus cephalotes*. Suggestions are made as to the deposition of pigments in the superficial layer of the cuticle in many larvæ immediately before pupation, and upon the hereditary transmission of pink colour in the tubercles of *Saturnia carpini*.

Attention is called to the high protective specialization of the imago of *Gonoptera libatrix*, where the otherwise conspicuous eyes and antennæ are hidden when the insect is at rest.

The paper also contains remarks upon the advantage resulting from the late emergence of females from the pupa, and upon the greater readiness of larvæ in the younger than in older stages to feed on different plants. It is suggested that carnivorous habits are induced by a lack in the supply of the normal vegetable food.

Mr. Poulton and Dr. Dacey have both noticed the tendency of young larvæ to seek the light. Some kept in a glass cylinder congregated always where light was strongest. Larvæ also seem to appreciate the influence exerted by the force of gravitation.

Sound Organs of the Green Cicada.†—Dr. A. H. S. Lucas, after referring to the theory of Landois, mentions the recent defences of the older explanation of Réaumur offered by Prof. Lloyd Morgan and himself. He then states that the stridulating organ of the male *Cyclochila Australasiæ* is formed by a specialization of the tergum of the first abdominal and the sterna of the last thoracic and first abdominal segments. A pair of rattle membranes with chitinous ridges is borne dorsally, and these are moved, to produce the sound, by tendinous slips from the exaggerated abdominal muscles of the two segments involved. Ventrally, on each side, two delicate tense

* Trans. Entomol. Soc. Lond., 1887, pp. 281-321.

† Trans. and Proc. Roy. Soc. Victoria, xxiii. (1887) pp. 173-8.

membranes inclose three air-spaces which act as resonators, and are formed by the suppression of visceral and muscular elements. These essential organs are covered and protected by stout chitinous plates—a pair projecting forwards over the sclerous rattle membranes, and another pair arising externally to the legs in the mesothorax, and extending backwards to cover the air-chambers. The modifications are merely suggested in the female. A series of experiments is described which point clearly to the functions of the various organs as assigned to them by Mr. Lucas, and dissections and plates accompany the paper.

Structure of the Head of Blow-fly Larva.*—Prof. B. T. Lowne has come to the conclusion that embryology shows the futility of discussion with regard to the segmentation of the head in insects; he compares them with those which have been held with regard to the vertebrate skull; no segmentation occurs in the pre-oral region, and the head consists of an unsegmented pre-oral cap, developed from the cephalic fold, of two lateral procephalic lobes, and of three post-oral segments with their three pairs of lateral appendages. The antennæ are developed from the non-segmented pre-oral region, and, like the eyes, have no homologies with limbs. “A comparison between these structures and the post-oral appendages has no more basis in their developmental history than a comparison of the trabeculæ craniî with the ribs, or of the sense corpuscles of a vertebrate with its limbs.” Mr. Lowne is of opinion that the whole exterior of the proboscis, except the labrum, represents the galeæ and stipes of the maxillæ, while the edges of the labrum and its apodemes represent the lacinia; if this view be correct there is nothing abnormal in the position of the maxillary palpi.

Sexual Generation of Chermes.†—Dr. F. Blochmann has elucidated an obscure point in the life-history of *Chermes* in discovering the sexual generation. The observations of Ratzeburg, Leuckart, and others had long since demonstrated (a) that a parthenogenetic, wingless generation passed the winter and deposited eggs at the base of the buds of the pine, (b) that their progeny developed in the galls and emerged in early summer as a parthenogenetic winged brood, and (c) that these produced a small yellowish wingless generation. It was supposed, direct evidence not being forthcoming, that the latter became the parthenogenetic winter generation (a) above referred to.

This Blochmann has shown to be a mistaken inference. The yellow coloured brood are *sexual*. Males and females are readily distinguishable, the former by the brown colour of the posterior portion of the body and by their very active habit. They possess two conspicuous testes and a penis beset with barbs. The females are yellow and not brown posteriorly, and of sluggish habit. They possess a single oviduct, two accessory glands, and a receptaculum seminis full of sperms. Both sexes exhibit a well-developed proboscis and alimentary canal.

After impregnation, the females hide at the bases of the needles on the somewhat thicker branches. There they lay a few eggs and die. From these fertilized ova the winter (a) parthenogenetic forms result. These are found at the bases of the buds from October onwards. The entire life-history thus closely resembles that of *Phylloxera*.

* Journ. Quek. Micr. Club, iii. (1887) pp. 120-4.

† Biol. Centralbl., vii. (1887) pp. 417-20.

β. Myriopoda.

New Species of Myriopoda.*—Mr. J. McNeill gives descriptions of twelve new species of Myriopods, chiefly from Indiana. *Hexaglena* is the name applied to a new genus, in which there are six eyes, arranged in two divergent lines, close to the bases of the antennæ; the head is conical and minute, and there are spiracles in one row on each side of the body. The new genus differs from its nearest allies *Octoglena* and *Petaserpes*, in that the former of them has eight eyes, and the dorsal aspect of its head exposed, and the latter has only two eyes, while its spiracles are arranged in two rows. *H. cryptocephala* is a new species. The other new forms are *Polydesmus castaneus*; *Trichopetalum bollmani*, which is allied to *T. glomeratum*; *Lisiopetalum endasym*; *Iulus multiannulatus*, which is 165 mm. long, and is the largest species of the genus yet described from North America; *Geophilus brunneus*, *G. indianæ*, and *G. varians*; *Mecistocephalus strigosus*, and *M. foreatus*; and *Scolopocryptops nigridius*, which in general appearance and habits resembles *Lithobius*.

δ. Arachnida.

Phylogeny of Arachnida.†—In discussing the systems of organs in the Arachnida, Herr B. Weissenborn rightly commences with the nervous system, as questions of homologies between the appendages can only be answered by reference to the innervation. The nervous system of Arachnids is distinguished from that of most Arthropods by the absence of antennary nerves, but there are many points of agreement which show us that the system in all Arthropods exhibits a more or less well-marked segmental development and distribution; they all agree in having the parts derived from epiblastic thickenings, but in the Crustacea the rudiments are continuous, while in Arachnids and Myriopods, the rudiments of the central portion are distinct from those of the ventral medulla, and in insects they are only loosely connected. So far then the Arachnida agree with the Insecta and Myriopoda. With regard to histological structure and composition they all agree. The Tardigrada and the Pycnogonida present considerable variations from what is normal among the Arachnida.

The dermal skeleton of Arachnids, like that of other Arthropods, is a product of the integument, and differs considerably both in its qualitative and its quantitative development; the most various relations obtain with regard to external jointing. Here again the Tardigrada and the Pycnogonida are the most abnormal. In the former, and in the Acarina, the homonomy of the body segments, and the union of the anal and genital orifices are sharp marks of distinction, and coupled with other causes, seem to show that the Tardigrada are the offshoots of a branch of the articulate phylum, which separated off much earlier than that of the Arachnida, and perhaps even than the Arthropoda.

The appendages are next considered; the diminution in the number possessed by the Linguatulida and their small size may be explained by the cestode-like mode of life of these forms. Here, as in the dermal skeleton and the nervous system, the Scorpionida and Solpugida are groups which exhibit a primitive character in many of their characters, and they must therefore be regarded as standing near an older stem-group. The Pycnogonida are again aberrant, while the Tardigrada give just the same kind of evidence with their appendages as with their dermal skeleton.

The respiratory organs are not to be regarded as modified gills, but

* Proc. U.S. Nat. Museum, 1887, pp. 323-34 (1 pl.).

† Jenaisch. Zeitschr. f. Naturwiss., xx. (1887) pp. 33-119.

merely as modifications of the respiratory organs which are found in *Peripatus*, the Myriopoda, and insects. There has been an adaptation to a lively mode of life, and, in correlation with the fusion of the segments and contraction of the hind body, a diminution in the number of stigmata. The great development of the skeleton of some has led to a marked localization of the respiratory apparatus of e. g. scorpions. The Solpugidæ present the most primitive relations of the thoracic stigmata, and the Scorpionidæ of the abdominal. While it may be supposed that the Tardigrada have lost their respiratory organs, the absence of them in the Pycnogonida must be referred to a primitive condition. Questions as to the homologies of the various stigmata can only be answered after an investigation into their developmental history; the original position of the openings may well be supposed to have been lateral and symmetrical. The diminution in the number of the stigmata has led to an increase of complexity in the tracheæ connected with those which are persistent.

e. Crustacea.

Green Gland of Crayfish.*—Prof. C. Grobben replies to the memoir by Herr B. Rawitz† on the green gland of the crayfish. In that memoir almost all Grobben's previous results were declared by Rawitz to be erroneous. In replying to the criticism Professor Grobben reasserts his original conclusions, and as a comparison of the two reports will show, is in direct conflict with Rawitz on six important points.

(1) The canal of the green gland does not exhibit any division near its passage into the sac. The terminal sac of the gland passes into the green portion, and that into the white region which expands into the sac. (2) The yellowish-brown terminal portion of the green gland is distinctly a sac with folded walls. (3) Its colour does *not* depend on a yellow colour of the nuclei, but on yellowish-brown bodies in the protoplasm of the epithelial cells. (4) The cells of the green portion of the gland exhibit towards the lumen of the duct a thick cuticle (Stäbchencuticula). (5) The occurrence of strands in the protoplasm of the cells is to be seen in the white portion also, and in fact very distinctly. (6) The terminal sac is richly provided with blood-vessels.

Embryology of *Mysis Chamæleo*.‡—Herr J. Nusbaum commences his account of the embryology of *Mysis Chamæleo* with a description of the external changes undergone by the egg in the course of development. Perhaps the most interesting point is that which treats of the blastoderm; like E. van Beneden, the author finds that the blastoderm appears in the form of a disc, the edges of which grow around the entire egg; but Herr Nusbaum finds that this disc appears on what will be the ventral surface of the egg.

The egg is covered by a delicate homogeneous or transparent membrane; the contents are largely composed of the nutrient yolk, formed of more or less large spheres, round grains, and droplets of fat. At what will be the ventral pole of the egg, and just below the membrane, appears a disc formed by a finely granular protoplasm, having in its centre a rounded and slightly elongated nucleus; the plasma, which is granular at its centre, is converted at the side of the yolk into a homogeneous protoplasmic layer, which refracts the light strongly. Later on two nuclei are formed by the segmentation of the primitive nucleus. After a lacuna in

* Arch. f. Mikr. Anat., xxx. (1887) pp. 323-6. † See this Journal, *ante*, p. 748.

‡ Arch. Zool. Expér. et Gén., v. (1887) pp. 123-44 (2 pls.).

his observations the author observed a stage in which the formative protoplasm was differentiated into two layers, the outer of which was finely granular, while the inner was more coarsely so, and contained large highly refractive granules; the nuclei of both these layers appear to be the products of the segmentation nucleus. The division of the nucleus of the outer layer gives rise to a small blastodermic disc, formed of a single layer of hexagonal cells.

The mesoderm is originally paired, and is formed by the division of the ectodermal cells on the thickened borders of the ventral streak; it continues even to develop during the naupliiform stage, in which three pairs of rudimentary appendages have the form of small sacs, made up by a layer of hexagonal cells. Corresponding with the segments indicated by these appendages, the mesoderm undergoes a rudimentary segmentation. The body-cavity is formed in the anterior part of the body by the absorption of the yolk which is surrounded by the mesoderm; in the hinder part of the body the yolk is surrounded by endoderm, and the space between ectoderm and endoderm is filled by isolated mesodermic cells; these, later on, become connected with the ectoderm and endoderm, and between them the body-cavity appears.

The types of segmentation hitherto observed in the Crustacea are essentially four, three of which are holoblastic. In *Palæmon* Bobretzky has found it to be complete and regular; after the division of the nucleus the ovum divides into two segmentation spheres; the internal portions of all the cells fuse into a central vitelline mass, which is surrounded by a blastodermic layer. Mayer found in *Eupagurus Prideauxii* that the nucleus divided into two, four, eight parts; the independent cells thus developed migrate towards the surface of the egg, and there is then a total and regular segmentation of the egg. Here also the internal ends of the cells fuse into a single central vitelline mass. In *Calianassa mediterranea* and in *Asellus aquaticus* the nucleus and the surrounding protoplasm undergo segmentation in the interior of the egg, and after the formation of a certain number of cells these migrate, as in *Eupagurus*; the yolk then commences to undergo superficial segmentation in such a way that a vitelline segment is differentiated around each blastodermic cell, while the centre of the mass undergoes no segmentation; this type reminds us of what happens in insects. In the Schizopoda and in *Oniscus* a mesoblastic segmentation has been observed.

Brain of *Mysis flexuosa*.*—M. R. Koehler finds that the elements of the nerve-centre of *Mysis flexuosa* offer no special characters, but that the dotted substance is a good deal reduced. The greater part of the non-cellular portions are formed of packets of parallel fibres, which form very distinct bundles; the masses of granular dotted substance interposed among the fibrils are neither numerous nor extensive, and most are easily resolved, with a high magnifying power, into a close plexus of anastomosing fibrils. The topographical relations were studied by sections taken along varying planes, but the descriptions refer so closely to the illustrations that a general account is here impossible. The structure of the ventral chain is extremely simple, and the ganglia only project slightly beyond the connectives; in the abdomen the ganglia are even more reduced than in the other parts of the body; the connectives are formed of longitudinal fibres; those of the first three ganglia are separated by a certain quantity of connective tissue, but beyond it they approach one another, and are only separated by a delicate partition.

* Ann. Sci. Nat.—Zool., ii. (1887) pp. 159–88 (2 pls.).

Shell of Hermit-crab.*—Mr. A. H. S. Lucas, commenting upon the usually accepted statement that hermit-crabs appropriate empty shells for protecting the defenceless part of the body, instances a case in which he observed the crab attack a living *Fasciolaria*, which it pulled out piecemeal after some time. From the appearance of the shells of tropical species of hermit-crabs Mr. Lucas is led to think that living rather than empty shells are usually seized.

Polar Globules in Isopoda.†—Herr G. Leichmann has observed the formation of two polar globules in *Asellus aquaticus*, and so has established an example of the ovum of a Malacostracan, richly provided with yolk, developing in the ordinary manner. As the presence of a nucleus in this stage has been denied by some writers the author desires to put its existence on record.

New Type of Compound Eye.‡—Mr. F. E. Beddard finds that in the retinula of *Serolis* there are only four cells. The rhabdom is not imbedded between them, but is only in contact at its upper part; the lower portion is surrounded by two large spherical transparent cells, which fit in closely between the four retinula-cells. The author has been able to find these hyaline cells in several species of Cymothoidæ. *Æga* has seven cells to each retinula, but the presence of the hyaline cells tends to confirm the view of many carcinologists as to the close relationship between the Serolidæ and the Cymothoidæ.

Pale variety of *Asellus aquaticus*.§—Dr. R. Schneider gives the name of *Asellus aquaticus* var. *Freibergensis* to a pale variety of *A. aquaticus*, which has been found in the caves of Freiberg. The author considers that this new variety is of great interest as representing an intermediate stage between the two very closely allied species *A. aquaticus* and *A. cavaticus*. Another point of importance is the support afforded to the belief that forms which have become accommodated to subterranean life have a tendency to resort to young or embryonic conditions.

In *A. aquaticus* the pigment is well developed, and the general colour of the animal is, therefore, a deep brownish grey; its variety and *A. cavaticus* have no pigment, and are consequently milk-white in colour. The eye of *A. aquaticus* consists of four well-developed ocelli, almost imbedded in a continuous pigment-mass, and over each there is a closely connected and distinct cornea; in the variety the pigment-mass is by no means continuous, the cornea is indistinct and not closely connected with its ocellus; *A. cavaticus* has no eyes. The outer antennæ of *A. aquaticus* have about 60 joints, the variety 50–60, and these are more delicate and elongated; the other species has from 25–55. *A. aquaticus* and its variety have four coarse tactile setæ on the endopodite of the first pair of maxillæ, *A. cavaticus* has five, one of which is larger than the rest. The pedes spurii of the variety stand almost midway between those of the two species. The cuticular calcification of *A. aquaticus* is slight, and there are not many crystalline elements as there are in the variety, where, as in *A. cavaticus*, the calcification is well marked. In the characters of its long hepatic tubes the variety resembles the species with which it is associated. The excretory organ of the adult *A. aquaticus* forms a continuous tube on either side of the digestive heart, while in the variety these are more broken up,

* Trans. Roy. Soc. Victoria, xxii. (1886) pp. 61–3.

† Zool. Anzeig., x. pp. 533–4.

‡ Ann. and Mag. Nat. Hist., xx. (1887) pp. 233–6.

§ SB. K. Preuss. Akad. Wiss., 1887, pp. 723–42 (1 pl.).

just as they are in the young of *A. aquaticus*: those of the other species are not known.

Other juvenile characters which may be noted, are the reduction in the numbers of joints of the outer antennæ, and the presence, last of all, of pigment on the head, and especially near the eye.

Australian Cladocera.*—It is a well-known fact that the eggs of various fresh-water animals (notably those of Entomostraca) will withstand long desiccation, but still the experiments detailed by Prof. G. O. Sars have considerable interest. A correspondent sent him some dried mud from the shores of a fresh-water lake in tropical Australia. This mud was placed in water, and from it were hatched out one Copepod, one Ostracode, a species of Polyzoan, apparently belonging to the genus *Plumatella*, and five species of Cladocera. These last are made the subject of an exhaustive paper. The species all belonged to genera (*Daphnia*, *Diaphanosoma*, *Ceriodaphnia*, *Moina*, and *Leydigia*) already known from European waters, and the species of these genera themselves closely resemble those of the antipodes, notwithstanding that they came from localities thousands of miles apart, and which have entirely different environments. These facts recall to the author the close similarity, even identity, of the crustacean species of Italy and Norway, and he concludes that one cannot lay too great stress on the importance of birds in the distribution of these forms.

Vermes.

a. Annelida.

Anatomy of Earthworms.†—Mr. F. E. Beddard describes in *Eudrilus sylicola* n. sp. an arrangement of the ovary and oviduct in which these parts occupy precisely the reverse positions to those figured by Prof. Perrier; in fact, the oviduct lies in front of and not behind the ovary. Attention is further drawn to the fact that the ovary and its duct are connected with one another, and that, therefore, there is not the difference between Annelids and Hirudinea which is ordinarily stated to obtain. The organs called testes by Prof. Perrier are really the vesiculæ seminales.‡ The terminal portion of the male generative apparatus of *Eudrilus* offers some points of interest; the glandular nature of the prostate gland is masked by the great development of its muscular layers, which give to it its characteristic nacreous appearance; the thick muscular coat is formed, for the greatest part, by longitudinal fibres; the glandular tissue is divided into two layers, which present an unmistakable resemblance to the epidermis of the clitellum; in its posterior half the prostate is divided into two independent tubes; one contains the continuation of the lumen of the prostate, and the other at first contains merely a mass of glandular cells; a lumen is soon developed. The vasa deferentia, after entering the prostate, become very fine tubes. Each portion of the prostate becomes continuous with a narrow tube that leads to the penis; this last is a muscular process of the walls of the bursa copulatrix, and contains a median canal which is continuous with the lumen of the duct of the prostate gland. In the possession of a muscular coat to the vas deferens *Eudrilus* presents another point of resemblance to the

* Forh. Vidensk. Selsk. Christiania, 1886, 49 pp. and 8 pls. Cf. Amer. Natural., xxi. (1887) p. 186.

† Proc. Zool. Soc. Lond., 1887, pp. 372-91 (1 pl.).

‡ It seems to be but little known that in his 'Forms of Animal Life,' the late Professor Rolleston correctly figured the position of the testes in the common earthworm, so that he comes between Hering (1857, not 1852) and the rediscovery by Professor Bourne.

leech. It will be necessary to form a new family for the reception of *Eudrilus*.

Mr. Beddard next makes some corrections, and gives some further information as to the reproductive organs of *Acanthodrilus*, and concludes with a note on the genital setæ of *Perichæta houlleti*, which have the general shape of imperfectly developed ordinary setæ, but terminate at their free end in a distinctly bifid extremity, the ends being connected by a delicate membrane.

New Species of Earthworm.*—Mr. F. E. Beddard describes *Cryptodrilus fletcheri*, a new species of earthworm from Queensland, which appears to be closely allied to *C. rusticus* Fletcher. The calciferous glands occupy an unusual position, for, instead of lying to the sides of the intestine, they are placed below it, and each gland comes into close relations with its fellow. The nephridia are on the type of *Microchæta* and some species of *Acanthodrilus*; they consist of a complicated coil of glandular tubules; their orifices alternate in position from segment to segment, but always correspond to one of the setæ. The seminal vesicles present the remarkable arrangement described by Mr. Fletcher, for a pair is placed in the ninth and another in the twelfth segment, the intermediate segments being without them, and, as in *C. rusticus*, the prostates are large. There are four pairs of spermathecæ, and these are interesting as presenting a difference in the minute structure of the spermatheca and its diverticulum, the latter having a very delicate epithelium, and the former tall columnar epithelial cells.

Anatomy of Hirudinea Rhynchobdellida.†—M. G. Dutilleul commences his notes on some points in the anatomy of the Rhynchobdellida with a discussion on the dorsal organ of *Glossiphonia*, which was first detected by Herr Nusbaum in *G. complanata*, where it is, however, provisional; it is also provisional in *G. marginata*, and the author believes that it is homologous with the permanent dorsal organ of *G. bioculata*; in this last it is nothing but a chitinous layer in a cutaneous depression, and M. Dutilleul thinks it would be well to call it the dorsal chitinous layer. With regard to the male apparatus of *G. sexoculata*, which it has been difficult to associate with that of allied species, on account of its abnormal form, the author states that he has discovered that the external branch of the U-shaped tube does not terminate in a free point, but is folded, directed backwards parallel to the axis of the body, and that it receives on its outer side the short deferent canals of the ten testicles of the corresponding side.

The wart-like tubercles of *Pontobdella* are found to be richly vascular and well provided with muscles, so that they represent differentiated respiratory organs, from which may be derived those of *Glossiphonia* and *Branchellion*.

Histology of Nervous System of Polychæta.‡—Dr. E. Rohde gives an account of his researches on the histology of the nervous system of the Aphroditeæ. His investigations mainly refer to *Aphrodite aculeata* Lin., *Hermione hystrix* Quatr., *Sigalion squamatum* Delle Ch., *Sthenelais dendrolepis* Clap., *Polynoe elegans* Gr. (*Lepidasthenia elegans* Mlmg.), *Psammolyce arenosa* Delle Ch. He prefaces his memoir with an historical résumé of the relative researches of the last twenty-five years. He discusses in order (a) the ganglion-cells, (b) the central substance, (c) the nerves, (d) the relation of the ganglionic processes to (b) and (c), (e) the subcuticular fibrous tissue. His principal results are as follows:—

* Proc. Zool. Soc. Lond., 1887, pp. 544-8.

† Comptes Rendus, cv. (1887) pp. 128-30.

‡ Zool. Beitr. (Schneider), ii. (1887) pp. 1-87 (7 pls.).

(1) All the parts of the system consist of an internal nervous substance and an external sheath. (2) The latter (the subcuticular fibrous tissue) is a fibrous modification of the subcuticula. (3) The former consists of a cortex of ganglion-cells imbedded in the meshes of the subcuticular fibrous tissue, and of a central substance inclosed by the above and formed from ganglionic processes.

(4) The ganglion cells are all unipolar and membraneless. They are either (a) small, clear, pyriform, disposed in packets, and with numerous equal-sized nucleoli, or (b) large, darkly granular, round isolated cells, with one large refractive nucleus, or sometimes two differing in character. They are sometimes of enormous size. The two types are connected by transition forms. (5) The cell consists of two substances (a) a granular, fibrillar mitom, and (b) an apparently homogeneous intermediate substance, the paramitom.

(6) The central substance consists of fine, non-anastomosing fibrillæ, regularly disposed across one another in the brain, but longitudinal elsewhere. The central substance is but sparsely penetrated by processes of the subcuticular sheath. In the nerves the fibrils do not form fibres.

(7) The delicate processes of the first type of ganglion-cell pass directly, those of the others by brush-like terminations, into the fine fibrils of the central nervous substance. The length of the processes before they fall into fibrillæ is very variable, it depends partly on the size of the cell. Most of them break up in the same segment, while others are extremely long (giant fibres), extending along the entire system, and even following the nerves to the periphery. (8) The giant nerve-fibres consist of an axial cylinder (the process of the giant-cell), and a fibrous sheath. In those of the ventral nerve-cord, there is a wide space between sheath and axis; this is traversed by fine lateral fibrils penetrating the fibrous sheath, and possibly connecting the axial cylinder with the fibrils of the central substance. (10) Both the giant fibres and the central substance include very peculiar, small, round elements, like small multipolar ganglion-cells. They give off 3-4 fine fibrils, which, in the central substance, mix with the ordinary nerve-fibrils, and in the giant-fibres pass across the space like the fibrils above noted as arising from the axis-cylinder. This arrangement probably secures a second connection between the axis-cylinder of the giant-fibres and the central nervous substance. (11) The processes of the peripheral ganglion-cells stand in the same relation to the nerves, as the processes of the central ganglion-cells to the brain and nerve-cord.

Formation of Germinal Layers in *Dasychone lucullana*.*—M. L. Roule has endeavoured to settle the question as to the origin of the mesoblast in polychæton annelids, which has been differently answered by Dr. Hatschek and Prof. Salensky. He finds that the ova of *Dasychone*, which are richly supplied with yolk, segment very irregularly; of the first two segmentation-spheres, one is small and contains the greater part of the germinal material, and the other is larger and is formed of a compact mass of vitelline granulations. The former divides more rapidly than the latter, and its segments gradually surround the yolk until only one point is left uncovered. This corresponds to the blastopore of the larvæ of *Eupomatus* studied by Hatschek; at this stage a cavity appears in the region opposite to the blastopore. From the inner layer, at the time when the blastopore closes, some cells separate which will give rise to the mesoblast; in all the sections which the author examined, the number of initial mesoblast cells appeared to be more than two. The central mass of elements charged

* Comptes Rendus, cv. (1887) pp. 236-7.

with vitelline granulations corresponds therefore to a meso-endoblast, from which the future mesoblast cells are the first to be differentiated.

Organization of *Chætopterus*.*—M. J. Joyeux-Laffaie has examined *Chætopterus Valencinii*. He finds that the median hinder groove does not stop at the level of the first pair of appendages of the median region, or continue on to the second, as various authors have stated, but that it bifurcates and goes on as two deep grooves; their function is to conduct to the oral infundibulum the food-particles brought by the current of water which passes through the tube of the worm, and they are therefore analogous to the endostyle of Ascidians.

The nephridia are remarkably developed in *Chætopterus*, but they are not found in the most anterior division of the body. The infundibulum is semilunar, and the whole of its internal surface is covered uniformly with long vibratile cilia. At the level of each appendage the tube is enlarged to form a pouch, which is of considerable size, and opens to the exterior by a short canal. The cilia on the lining epithelium are very well developed. The tissue of the walls of the nephridium is formed of elements which resemble the cells of the organ of Bojanus; when separated they are spherical in form, and they contain a large nucleus which has one or more concretions in its interior; they sometimes increase in size and unite, when they form a calculus which almost completely fills the cell. Free calculi are often found in the excretory canal or in the pouch, and then the cells which give rise to them disappear.

The sexes are separate, but the male and female gonads have the same form and position; the products accumulate in large quantities, and give to the male a pale white, and to the female a slightly rosy colour.

Histology of *Eunice*.†—Prof. E. Jourdan describes the histology of two species of the genus *Eunice*—*E. Harassii* and *E. torquata*. The cuticle is remarkable for its thickness, and is seen by the use of reagents to consist of superposed lamellæ, which sometimes give it a regularly striated appearance; the existence of pores is best demonstrated after the use of such reagents—e. g. Hoffmann's green—as colour the contents of the underlying glandular cells. The epidermis is formed of cylindrical epithelial elements and glandular cells; the former are connected with one another by basal anastomosing branches, and give rise to the arrangement which Claparède distinguished as stellar connective tissue. The glandular cells are irregularly disposed on the body, being very rare on the dorsal surface, and most common at the edges of the ventral; some of these cells are hyaline and some are granular in appearance, but both are modifications of a single type of anatomical element. When the muscular fibres are teased, the irregularity and often the bizarre appearance of their forms are the first point to attract attention; they seem to be very long, are irregularly flattened, and indicate waves of contraction by thickenings scattered very irregularly along their whole extent. The author thinks that he has found evidence of true nerve-endings in the muscles, and states that he has observed similar arrangements in Holothurians.

In the account of the central nervous system we must content ourselves with noting a few points: the dotted substance is composed of very delicate, homogeneous fibrils quite like those which are met with in the peripheral nerves; they form so inextricable a plexus that the dotted substance cannot be separated out; the spaces of the close and delicate plexuses are occupied by an interfibrillar protoplasm which is sufficient to convert the

* Comptes Rendus, cv. (1887) pp. 125-7.

† Ann. Sci. Nat.—Zool., ii. (1887) pp. 239-304 (5 pls.).

central nucleus of the brain into a homogeneous mass. In the ventral cord we find, below the central mass of nerve-fibres, a hyaline structureless space, which corresponds to what other authors have called a giant nerve-fibre. M. Jourdan refuses to regard this structure as nervous, and looks upon it as being an organ of support for the ventral nervous system. Among the investments of the cord is a pigmented mass, which is specially accumulated above it. This mass is lodged in a plexus of cells with branched and anastomosing prolongations, and the cells themselves appear to be comparable to the plasmatic cells of the connective tissue of vertebrates.

After some account of the process of regeneration of the central nervous system, the author passes to the sensory organs, where the antennæ are first described; the eye has a crystalline lens provided with a capsule, formed by the folding over of a delicate portion of the body-wall; the body of the lens itself is semi-liquid, and is, possibly, analogous to the mucus secreted by the animal; the cells beyond it form the retina and vitreous body, and are nothing more than modified epithelial cells of the hypodermis; the author compares this simple eye with those of *Patella*, of Lamellibranchs, and with the simple eyes of Insects.

The digestive tract exhibits no indications of any glandular organ; the gills are essentially formed of two vessels covered by a layer of longitudinal muscles, and protected by an epithelium which is similar to that of the general surface of the body. The author thinks that there is no endothelial lining to the vessels of the Chætopoda; but as this would be a remarkable divergence from what obtains in other forms, he thinks it ought to be verified.

The observations on the "pedal glands," the lateral pigment-organs, and the segmental organs are collected into one chapter, as these parts have been long regarded as the same. The term of pedal gland is applied to the organ which Claparède regarded as pouring its secretion on to the setæ. Immediately beneath the setæ of each segment there is a mass of cells, which form a sort of epithelial bud on the internal surface of the integument. A superficial examination will suffice to show that these cells do not differ from the glandular elements which are found in the epidermis. They are so pressed against one another as to form a sort of multilobate racemose gland, the product of which passes to the exterior by a number of pores; these glands are better developed in *Eunice Harassii* than in *E. torquata*. The lateral pigment-organs were rightly regarded by Claparède, in opposition to Ehlers, as quite independent of the segmental organs; as to these last, which are very difficult to observe in most species of the genus, the great Swiss naturalist was unable to detect the external orifice. M. Jourdan comes to the conclusion that the organ opens to the exterior immediately below the pedal gland; the peripheral portion is formed of a membranous tube with flat cells on either surface, and appears to be rather an efferent vessel for the genital products than an organ of secretion.

Nervous System of Opheliaceæ.*—Dr. W. Küenthal gives a detailed account of the structure of the nervous system in the Opheliaceæ.

Along the median line of the ventral surface there extend two parallel strands, which diverge and run to points at both ends, forking anteriorly so as to surround the gut. In two regions the strands are united, in the anterior portion of the head, and along the whole region from the anus to the third tail-segment. The two fibrous strands are surrounded by groups of ganglion-cells, and a common neurilemma ensheathes the entire system. Each segment contains two or three ganglionic aggregations. These give

* Jenaisch. Zeitschr. f. Naturwiss., xx. (1887) pp. 511-80 (3 pls.).

off processes, in part to the nerves, in greater part to the longitudinal strand of the opposite side, and to a small extent to the longitudinal strand of the same side. The differentiation of ganglia and connecting commissures is not yet complete. Each complex of nerve-cells, the processes of which form part at least of each pair of nerves, is to be regarded as a ventral ganglion. There are four pairs of aggregates in each group, two lateral and two internal, two ventral, and two dorsal. As a portion of the processes of the lateral cells passes to the other side, two bridges are formed, one ventral and one dorsal. In each segment there are two or three such double bridges, and corresponding to these two or three pairs of nerves passing out from the same plane.

The strands surrounding the gut have the same structure. On their lower portion lies a ganglion, which in structure corresponds to half of a ganglion from the ventral cord. The same groups of cells are present except the median internal. Since the strongly developed sympathetic springs from this œsophageal commissure, the latter may be termed the stomatogastric centre.

The brain exhibits three pair of ganglia. Into both brain and ventral cord ectodermic elements enter. The upper surface of the brain exhibits a group of large round cells, possibly remnants of the apical plate of the larva.

The free-living forms (*Armandia*, *Polyophthalmus*) have a perfectly developed brain, while the ventral cord is still associated with the ectoderm; those creeping in the mud (especially *Travisia*) have the ventral nerve-cord completely separate from the ectoderm, but a reduced brain and sensory system. The memoir concludes with a comparison of Opheliaceæ and Archiannelids.

B. Nemathelminthes.

Anatomy of Gordiidae.*—M. A. Villot is of opinion that Prof. Vajdovsky would have avoided some of the errors into which he has fallen with regard to the structure of the Gordiidae, if he had made sections, had been able to examine the worms in the fresh state, and had a knowledge of their larval development. The French author has lately been so fortunate as to get examples of the parasitic stage of *G. violaceus*, which is passed in the abdominal cavity of *Procrustes coriaceus*.

The resemblance of the rings of the integument of embryos and larvæ to the segmentation of Annelids is apparent only, for they are merely due to folds of the integument. The fibrillar and nervous nature of the hypodermis is maintained, but M. Villot finds he was wrong in regarding the so-called nuclei as having any relations to the fibrillar elements; they are vascular organs which are connected with the pores of the epidermis and the aquiferous canals which traverse the dermis. To understand the origin and histological significance of the elements of which the integument is composed, it is necessary to study them in the parasitic larvæ before the formation of the dermis. Beneath the epidermic cuticle, there is a layer of embryonic cells, which, seen from above, is very like a pavement-epithelium; in each cell there is a large nucleus which stains well with carmine; on making a longitudinal section, it is seen that these embryonic cells have their protoplasm formed of developing fibrils, while their nucleus becomes vesicular and gives off at each pole a tubular prolongation; the ventral plexus and the central nervous system are only a special development of the fibrillar elements of the hypodermis, and the author was, therefore, wrong in previously ascribing to them a mesodermal origin.

* Ann. Sci. Nat.—Zool., ii. (1887) pp. 189–212.

On a previous occasion M. Villot has insisted on the homology of the muscular fibres of Gordiidae and Nematoids; he has since been able to detect a phase in the development of the muscular fibre of *Gordius* in which it is for a time in the stage in which those of Nematoids are permanently; the fibrillar substance only invests part of the inner wall of the embryonic cell, and the as yet unchanged portion is represented by a vesicular enlargement which is adherent to the parenchyma.

Some additions are made to our knowledge of the interesting phenomenon of the retrogression of the digestive tube, and it is found that what has been hitherto taken for the mouth of young *Gordii* is really an invaginated proboscis; it is the rostrum of the embryo which persists during the whole duration of the parasitic life, and only disappears in the adult when its cuticle is completely chitinized. The fibrous layer in the wall of the intestine is not muscular, but elastic in nature, and its development is more marked as the tube diminishes; in fact, it is these fibres which cause the contraction of the intestine.

There is really but one pair of ovaries, but each divides into two tubular branches, while the dorsal canal of Vejdovsky is a fifth unpaired and rudimentary branch; the receptaculum seminis is homologous with the ovaries; various points in which Vejdovsky appears to be in error with regard to the genital organs and the parenchyma are indicated.

The Gordiidae are essentially characterized by their embryonic rostrum and the structure of their genital organs, as well as by the relative superiority of their integument, parenchyma, muscular and nervous system, and they should be distinguished from the Nematodes.

Development and Determination of free *Gordii*.*—M. A. Villot urges again attention to certain points in the life-history of *Gordius*, which appear to be still insufficiently recognized. They are: (1) these parasitic worms may leave their hosts at very different stages in development; (2) the chitinization of the cuticle causes, in adult individuals—whether free or parasitic—changes in coloration, form, and structure; (3) individuals of the same species may, even when completely developed, present very considerable differences in size. Having given evidence in support of these statements, the author proceeds to point out the importance of their bearing on the specific distinctions of various *Gordii*. We must be careful only to compare individuals of the same sex and age—in other words, forms of the same degree of chitinization, and we must be careful about the different phases of the chitinization of the cuticle in individuals of the same species. The forms lately described by Camerano—*G. Perronciti*, *G. Rosæ*, and *G. Piottii*, are all examples of the polymorphous *G. aquaticus* (or *G. subspiralis*). To be quite certain about the characters of a species of *Gordius* a large series of specimens must be compared.

Brown Cysts of *Anguillula* of the Beetroot.†—M. J. Chatin finds that under certain circumstances, and especially on the approach of winter, the females of *Heterodera Schachtii* undergo peculiar changes. The delicate integument gradually thickens, its glands furnishing an abundant secretion, which agglutinates organic and mineral substances, and so forms a sort of adventitious test around the female; this carapace closes up the buccal, anal, and vulvar orifices, and all connection between the worm and nourishing plant is broken. We have now a cyst filled with eggs, and comparable to an ootheca. It is easy to see how such a cyst can withstand the influences of bad weather. Later on, under more favourable conditions, the

* Zool. Anzeig., x. (1887) pp. 505-9.

† Comptes Rendus, cv. (1887) pp. 130-2.

walls will swell and soften, and allow the eggs to escape. The importance of the knowledge of the life-history of this parasite will be obvious.

Anatomy of Echinorhynchi.*—The Acanthocephali have been regarded as devoid of a digestive apparatus, and Lespè's discovery of what he considered the elementary tract in the pyriform body in the proboscis of *Echinorhynchus claviceps* met with but little acceptance. Recently M. P. Mégnin has been studying the subject, and gave the result of his researches before the Scientific Congress of Paris.

In order to settle the question, it was necessary to study these worms at a period before the development of the sexual organs, and when the nutritive system was in full function. Mégnin found *Echinorhynchi* encysted in the cellular tissue of Varanidæ from the Sahara. These proved to be in a larval stage, and to have a digestive apparatus composed of two long convoluted tubes, each giving rise to numerous cæcal diverticula. The whole presents an analogy to the alimentary tract of the Trematodes. In some species, as the *E. brevicollis* found in *Balænoptera sibbaldi*, the digestive apparatus persists and acquires considerable development. In others it undergoes a degeneration, and is to be sought in the "lemnisci," structures, heretofore, of problematical nature, occasionally regarded as salivary glands. The larvæ have a rudimentary dorsal vessel, and this, with their proboscis and aquiferous apparatus (which, however, is well developed in the adult), shows the relation of the Acanthocephali to the Nemerteans or Rhynchocœla, while the digestive apparatus is more like that of the Trematodes. They can no longer be arranged with the Nematodes.

Development of Echinorhynchus gigas.†—Herr J. Kaiser has a preliminary report on the development of *Echinorhynchus gigas*. He finds that the ovaries, as soon as they are set free from the ligament, appear as elongate oval plasmatic discs, in which there are a number of granules of various sizes, and a considerable quantity of fat-like nuclei. The latter, with growth, either pass to the periphery of the ovary, increase in size at the cost of the rest, and form a simple layer of polyhedral cells, which invest the ovarian disc completely, or serve as nutrient material. As the cells of the epithelial investment grow, their colourless protoplasm becomes granular and turbid, and forms spherical structures, which move about freely in the cell-capsule. The spherical gives way to a spindle-shaped body, which bursts away from the ovary, and comes into contact with the spermatozoa. When impregnation is effected the egg becomes surrounded by a delicate clear membrane; the nucleus disappears, and the yolk begins to divide; segmentation is very irregular.

When there are about a dozen blastomeres a second embryonic envelope appears beneath the first; on the inner surface of the outer membrane a number of dark lenticular bodies become developed, and give rise to a shell, with which, in course of time, two other supporting membranes become connected.

During the development of these coverings the embryo has made further progress; there is an epibolic gastrula, and at one end the epiblast forms a considerable projection, in the centre of which there are six to eight nuclei; this syncytium is clearly the commencement of the nerve-centre. Later on a similar but less well developed cone appears at the aboral pole of the body. The embryo now obtains its covering of spines; between every four approximating epiblast cells there arises, as a secretion-product, a small thorn-like process.

When the last sign of the central yolk disappears the embryo undergoes histolysis, the cell-walls disappearing, and the plasmatic bodies uniting; the nuclei are completely filled with highly refractive chromatin, and pass to the centre of the body, where they unite to form the so-called embryonic granular masses.

The syncytial plasma becomes differentiated into two layers; the inner one has in its centre the nuclear masses. In this condition the eggs pass out with the faeces of their host, and make their way into the intestine of the larva of *Cetonia aurata*.

The embryos, by the aid of their boring apparatus, bore through the chitinous lining of the lumen of the intestine, and through the glandular into the subjacent muscular layers. The free and exceedingly agile embryo has the form of a wide flask with a spherical base; besides the numerous small spines, which thickly cover the whole body, it has five large hooks, which are placed at the anterior end, and can be withdrawn into it. In their resting-place the embryos increase considerably in size; the first change which becomes apparent is that six nuclei become set free from the anterior end of the central nuclear mass; these become surrounded by a common plasmatic mass, which gradually assumes the form of an equilateral cone. On each of the six nuclei a small hook appears, in which it is not difficult to recognize the spinous process of the definite holding organ; when they have attained a certain size they pass forwards, and six fresh hooks appear; this process is repeated for from five to seven times. Almost simultaneously with the proboscis the rudiment of the body-covering of the definite worm is laid down in the form of a large-vesicled syncytium. In the anterior region the nuclei are laid down in two parallel zones. When the larva is from 4–5 mm. long the chief syncytium becomes converted into a simple layer of high cylindrical cells. The latter secrete a colourless mass, which later on hardens into the fibrous tissue of the subcuticula. But before this happens the first primitive muscle-fibres appear in the vertical walls of the cylindrical cells; these increase in number very rapidly; they break through the outer limiting membrane of the cells, and make their way into the still soft fibrous tissue of the subcuticula.

The endoderm gives rise to the body-musculature, the gonads, and the efferent genital ducts; the syncytial origin of the first of these is described.

γ. Platyhelminthes.

Developmental Cycle of *Tænia nana*.*—Prof. B. Grassi, in commencing his observations on the developmental history of *Tænia nana*, believed that the intermediate host of this human parasite was the mealworm. But all the experiments which he made were useless, as were also those made on animals, such as edible molluscs, lice, and so on, with which man comes into contact. The suggestion then recommended itself that, neither with this worm nor with *T. murina* was there an intermediate host at all. Trying this with young white mice, and carefully looking to their food after having fed them with *T. murina*, Prof. Grassi found that in fifteen days the *Tæniæ* had mature proglottids, and after about thirty days the eggs appeared in the faeces. Closer investigation showed that within fifty hours after feeding with proglottids the oncospheres of *T. murina* were found greatly increased in size in the terminal ten centimetres of the small intestine, where they were flask-shaped, and not unlike the bodies seen by Melnikow in *Trichodectes*. The embryonic hooks are ordinarily placed on the neck of the

* Centralbl. f. Bakteriöl. u. Parasitenk., i. (1887) pp. 305-12.

flask; about the middle of the belly calcareous corpuscles were sometimes observed, and what appeared to be rudiments of suckers were seen on the neck. By the time that seventy hours have elapsed six embryonic hooks were observed on the neck; only a very narrow cavity, filled with fluid, lies between the scolex of the *Tænia* and the simple cyst which encloses it. There is no definite boundary between the scolex, the cyst, and the "neck"; and this last may be called the caudal appendage.

After these experiments with *T. murina*, which served to convince the author that he had here to do with a direct development of a tapeworm without the assistance of an intermediate host, he and Calandruccio made experiments with the same *Tænia* on six human beings—four adults and two boys. A boy of five years of age, fifteen days after swallowing a number of proglottids of *T. murina*, had a certain quantity of ova of *T. nana* in his fæces, and, on being treated medicinally, passed fifty pieces of the latter tapeworm. Although these experiments are not conclusive, they lead to the supposition that this worm also ordinarily develops directly, and Prof. Grassi thinks that the same is true also of *T. elliptica*; at times they may develop indirectly, and, as the cysticerci of *T. mediocanellata* are very rare, it, too, may perhaps be another example of direct development.

Malformed Example of *Tænia saginata*.*—Prof. C. Grobben describes a specimen of *T. saginata* taken from a child six years old. Its form and coloration was such as to call to mind *Cerebratulus marginatus*. The portion examined was found to consist of a broad lower piece, and an upper somewhat narrower portion, separated by a constriction, and it measured in all 128 mm. There was no sign of jointing, so it was clear that the author had to do with a portion of a *Tænia* in which the formation of proglottids had not taken place; examples of this kind of arrest of development has already been put on record by Prof. Leuckart.

Sensory Organs of Turbellaria.†—Dr. L. Böhmig publishes a preliminary account of his investigations on the sensory organs of Turbellaria. In *Planaria gonocephala* the eyes have a long diameter of about 0.18 mm., while the other two dimensions are about 0.1 mm.; each eye has an investment of pigment formed of small blackish-brown spherules, and its convex side is surrounded by a delicate fringe of finely granular protoplasm, in which a number of distinct rounded nuclei can be made out. The presence of them would seem to show that the pigment-covering is derived from several cells, whereas in the eyes of Polyclads there is only one nucleus in the protoplasmic fringe. The so-called optic ganglion consists of a central ball of dotted substance, around which retinal cells are grouped. The optic nerve arises from a part of the brain where the dotted substance is distinguished by its greater fineness and more homogeneous appearance; this is the case also in some snails. The cells of the optic ganglion have a large nucleus, and though unipolar, each process soon divides into a number of smaller ones. The end-bulbs are not merely hyaline structureless bodies, but present a longitudinally striated thickening, which is separated by a thin hyaline plate from a finely granular terminal cap. As no lens could be detected, the author suggests that its function is performed by the parenchymatous tissue between the retina and the epithelium, which is viscous and transparent during life.

Among the rhabdocæalous Turbellaria, the Plagiostomida, which may have four eyes, have these organs more complicated than the Monotidæ.

* Verh. Zool.-Bot. Gesell. Wien, xxxvii. (1887) pp. 697-82.

† Zool. Anzeig., x. (1887) pp. 484-8.

A brief account is then given of the eyes of *Vorticeros auriculatum*, and *Enterostoma striatum*; in the latter the pigment-capsule contains two spherical structures, which, in well-preserved examples, exhibit a distinct longitudinal striation, due to the presence of extremely delicate bacilli, enclosed in a delicate intermediate substance. In these two forms lenticular cells are probably present.

In *Plagiostoma Girardi*, the contents of the pigment-capsule consists of two distinct substances; the larger hinder part of the cup is filled by a completely homogeneous substance which is only faintly stained by reagents; in front of it is a delicate band which is not coloured, but has no distinct horizontal striation. In front of the pigment-capsule is a group of cells, of which the central are larger than the peripheral. The structure regarded by Graff as the lens, consists of the contracted contents of the pigment-capsule which ought to be considered as the nerve-end apparatus.

The subcutaneous nerve-plexus, which, according to Lang and Ijima, is most apparent on the dorsal surface of Planarians, is to be seen in *P. gonocephala*, where it is best developed in the cephalic and auricular portions, and connected with it is an apparatus developed on the auriculæ, which may be regarded as an end-organ. On the dorsal surface of these processes there are small pits with a sharp and fine contour; at the base numerous nerve-fibres enter the pits from the subcutaneous plexus, and pass to a reniform body which fills the median third of the depression; this body is fibrous in structure, and from its free surface there project a number of thick round setæ, provided at their free ends with small capitula. The author suggests that the function of these organs is tactile.

Planaria Iheringii.*—Dr. L. Böhmig gives a general account of a new tricladiid Planarian from Brazil. The worms are from 3·5–5 mm. long, 2–3 mm. broad, and 0·05 to 0·75 mm. thick. The ground-colour is bright yellowish-brown, or dirty whitish-yellow. At the edge of the head there are two whitish spots which project slightly beyond the margin of the body, and are the auricular processes. In the hinder third of the body are two orifices, one of which is the oral and the other the genital; the former leads to a pharynx, which, when completely protruded, is 1·4 mm. long; the latter to a narrow cleft which opens into a space largely occupied by the muscular penis; this space is the atrium genitale, and into it there open the vasa deferentia. The saccular uterus is of some size, and lies between the wall of the atrium and that of the pharyngeal space; its duct is provided with a highly developed musculature, and the two oviducts open separately into it. The paired germaria lie at about 0·8 mm. from the anterior pole of the body, while the vitellaria and testes lie in front of and behind the copulatory apparatus. The structure of the generative apparatus of this new species is of the type found in *Planaria polychroa*.

Graffilla Brauni.†—Herr F. Schmidt has discovered a fourth species of *Graffilla*, which he calls *G. Brauni*; it lives parasitically, and apparently abundantly, in *Teredo*; the largest specimens are from 2·5 to 3·2 mm. long, and about 1 mm. broad; the colour is generally whitish yellow. The protoplasm of the epithelial cells is, as in *G. muricicola*, finally striated; no rhabdites were observed; the dermomuscular tube is fully developed. The meshwork which forms the supporting substance of the body-parenchyma is extraordinarily fine, so that with low powers, the parenchyma has almost the appearance of a completely homogeneous mass. The new

* Zool. Anzeig., x. (1887) pp. 482–4.

† Arch. f. Naturgesch., lii. (1887) pp. 304–18 (2 pls.).

species agrees generally in the disposition of its venous system with *G. muricicola*; well-marked eyes are present. Like the just-mentioned species, *G. Brauni* has a kind of boring apparatus by means of which it is able to penetrate the body-wall of its host. The successive hermaphroditism of the genital products is not quite so well marked as in *G. muricicola* or *G. thetydicola*, for in moderately sized examples all the parts of the male apparatus are developed, while the female germ-glands were already ripe, and it was only in the largest individuals, where the ovaries were greatly developed, that the tubes were found to have completely disappeared. The female apparatus consists of germ-glands, vitellaria, atrium genitale with its appendix, receptaculum seminis, and shell-glands; the uterus communicates with the exterior by a very narrow genital canal. As in the two species already mentioned, the germaria have no membrane. In quite young individuals the ovary consists of a mass of finely granular protoplasm in which numerous nuclei are scattered; in the organs of older animals the protoplasm breaks up into the characteristic germinal discs.

G. Brauni appears to have an excretory system which differs a good deal from that of *G. muricicola*. Where a specimen is examined from the dorsal side, two large pyriform vesicles may be seen in the anterior fourth of the body; these open to the exterior by an extremely short fine canal between the epithelial cells. From each vesicle a ramifying canal extends backwards and forwards, but these could not be traced far, and they doubtless become very fine. The vesicles are invested by an extremely delicate membrane.

Dendrocœlum punctatum.*—Dr. W. Weltner gives a description of the large Planarian *Dendrocœlum punctatum* Pallas, which he found in the Tegelsee and also in the Spree near Berlin. He notes the external characters, the formation of cocoons, the number and appearance of the larvæ, but as his results are for the most part corroborations of the investigations of de Man and Hallez, the communication is almost exclusively of faunistic interest.

δ. Incertæ Sedis.

Dicyemidæ.†—Prof. M. Braun gives an account of what is known as to the curious parasites called *Dicyema*, first observed by Krohn in the "venous appendages" of the Cephalopoda, which will be useful for those who are unacquainted with the investigations that have been made on them. He concludes with a list of known species taken from Prof. Carus's 'Prodromus Faunæ Mediterraneæ.'

Anatomy and Systematic Position of Echinoderes.‡—Prof. W. Reinhard gives a detailed account of the anatomy of this enigmatic worm, and discusses the various suggestions that have been made as to its systematic position. He is himself inclined to associate it most closely with Annelids. With regard to its segmentation he is unable to accept the view of Hatschek that it is merely external and due to their mode of locomotion. The forward movements of *Echinoderes* are performed by the aid of the proboscis, and all other movements are very feeble. In his view, segmentation has not been independently acquired, but has been inherited; it is not only the outer covering that is segmented, but the whole body-wall corresponds, while in each segment there is a thickening separated by a constriction from its successor.

The most important peculiarity, in Prof. Reinhard's opinion, is the

* SB. K. Preuss. Akad. Wiss., 1887, pp. 795-804 (1 pl.).

† Centrabl. f. Bakteriöl. u. Parasitenk., ii. (1887) pp. 386-90.

‡ Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 401-67 (3 pls.).

presence of setæ which traverse the carapace and are connected with the body-wall. These setæ completely correspond to the setæ of Annelids, and they form a transverse row in the midst of each segment in some species. Although, as a rule, Annelids are characterized by the presence of circular muscles, yet such are absent from *Polygordius*.

The external heteronomy of the segments in *Echinoderes* is almost as well marked as in Annelids. The excretory organs of the two groups undoubtedly correspond, and, as their number varies among Annelids, we need not wonder at their being reduced to a minimum in *Echinoderes*. The absence of an orifice from the anterior end of the segmental organ of the latter may be only apparent.

On the other hand, we must not omit to notice the important differences which undoubtedly exist between these two groups. These are the characteristic union of the plates of the carapaces between the separate segments, the absence of a distinct head, and the peculiarities of the musculature in *Echinoderes*; this form wants the parapodia, cirri, and gills so characteristic of Annelids, and cilia are found only in the excretory organs. Unless the muscles which extend from the back to the ventral surface are dissepiments, septa are wanting, and there is no ventral nerve-cord. No less important differences are presented by the reproductive organs, the absence of a circulatory system, the digestive organs, and the mode in which *Echinoderes* moves by the aid of its characteristic proboscis.

All these are sufficient to prevent the union of *Echinoderes* and Annelids in a single class, and for the former it is proposed to establish a special class, which, from the mode of locomotion, may be called the Kinorhyncha. The characters which the two groups possess in common may be explained by the supposition of the previous existence of a group of Proto-annelids (!), whose body was segmented, and had setæ and segmental organs of the primitive form, terminating as do those of Cestoda and Trematoda. All the suggestions here made must, however, be regarded as open to revision when the development of *Echinoderes* has been studied; of this at present nothing is known.

The species of the genus appear to live at the bottom of the sea in muddy and sandy places; near shore, where shells of Mollusca abounded, it was not found. In the neighbourhood of Odessa they do not live in any number at less than seven or eight fathoms depth, but in the open sea they were found in shallower waters. Eighteen species are already known, and the genus is very probably cosmopolitan.

Dinophilus gyrociliatus.*—Herr W. Rapiakhoff has made a fresh study of the much discussed worm *Dinophilus*. (a) In regard to the species, the author maintains that the *D. apatris* so carefully described by Korschelt, and other species described by various authors, are identical with the original species discovered in 1848 by O. Schmidt, *D. gyrociliatus*. (b) His anatomical and embryological investigations corroborate those of Schmidt and Korschelt, and the new points elucidated are relatively unimportant. The author's attention was concentrated on the female form. (c) In regard to the much discussed question of the systematic position of *Dinophilus*, Rapiakhoff canvasses the various opinions, and especially those represented by Lang and Korschelt, who refer it respectively to the Proto-annelids and to the Tubellarians. He sums up by defining its position as that of a "side branch from the Annelid stem, extricating itself from the Trochozoon type, and developing between the Rotatoria and the Proto-annelida."

* Mém. Soc. Néo-Russ. Nat. Odessa, x. (1886) p. 2. Cf. Arch. Slav. de Biol., iv. (1887) pp. 112-3.

Bipalium kewense.*—Though Mr. R. Trimen has found *Bipalium kewense* at the Cape of Good Hope, he is unable to give us any information of its exact habitat, for all the specimens seen by him have been found in cultivated grounds. He has observed multiplication by transverse fission, and the growth of the pieces. Abundant moisture is necessary to keep the worms alive.

New Rotifer.†—Mr. J. Hood describes a new species of the Rattulidæ, *Mastigocerca bicristata*, which he has found in marsh pools in Fifeshire and Perthshire. It is about 1/40 in. in total length, the long slender toe being nearly as long as the body. It feeds on *Confervæ*, desmids, and diatoms, and deposits its eggs among *Confervæ* or vegetable debris. The female only has been observed.

Balanoglossus Larva from the Bahamas.‡—In reference to his communication § on this subject, Mr. W. F. R. Weldon states that Prof. Spengel has convinced him that his series really belong to the normal order of development. He withdraws, therefore, his previous statement, and expresses regret for having published "an erroneous doctrine."

Echinodermata.

Development of Calcareous Plates of *Amphiura*.||—Mr. J. W. Fewkes has studied the development of the well-known viviparous Ophiurid, *Amphiura squamata*. He finds that the intestine of the bisymmetrical larva is early developed, and later in development undergoes atrophy; the mouth, and possibly the cesophagus of this larva are formed by an epiblastic invagination during the time that the larva is still inclosed in its sac, and remains attached to the parent. The provisional skeleton of the bilateral larva is not always symmetrical, and sometimes developes on one side; the first formed rod is not always a trifold calcification; the first calcareous plates which form on the abactinal hemisphere are the first five radials, and a little later, the dorso-central; the radials arise before the terminals. The first ambulacral are the plates which are first formed on the actinal hemisphere; the second pair of adambulacral plates bear club-shaped spines, which are homologous with the spines of the lateral plates of the arms. The first-formed ventral plate belongs to the first pair of adambulacral plates, and not to the lateral arm-plates; though not belonging to the portion of the arm which is free from the disc, this ventral plate is homologous with the other ventral arm-plates.

The radial shields arise before the "underbasal" is formed between the dorso-central and the primary radials, and while there are but two intermediate plates in each of the interradii; the author discusses the homology of the plates which are looked upon by Carpenter as the basals, and doubts whether the particular ones selected by him are truly basals. The ambulacral plates do not always arise in the form of trifold spicules, for they sometimes appear as parallel unbranched rods.

The ova of a parasitic Crustacean (? Copepod) ¶ were often found, and the specimens which contained them were distinguished by having one or more of the interradii regions of a reddish colour, and more swollen than the rest. While the eggs of the Crustacean are bright red or pink, and arranged in packets, those of *Amphiura* are red and orange and are not in free packets. The adult form of this parasite is also found in *Amphiura*.

* Proc. Zool. Soc. Lond., 1887, pp. 548-50.

† Sci.-Gossip, 1887, p. 173 (2 figs.).

‡ Proc. Roy. Soc. Lond., xlii. (1887) p. 473.

§ See this Journal, ante, p. 597.

|| Bull. Mus. Comp. Zool. Cambridge (U.S.A.), xiii. (1887) pp. 107-50 (3 pls.).

¶ Cf. this Journal, ante, p. 587.

Eocidaridæ.*—Dr. K. Kolesch has made a study of the characteristics of *Eocidaridæ keyserlingi*. In contrast to the true Cidaridæ it is pointed above; there are three different kinds of spines; individual variations were observed. It is not a Palechinid, but a Euechinid, for there are always two rows of interambulacral plates; mathematical computations show that there were twenty rows of plates, all the plates are pentagonal, and the lateral bounding line of the interambulacral areas is zigzag or notched.

New Holothurians.†—Prof. F. Jeffrey Bell gives descriptions of some new species of Holothurians from various localities. *Cucumaria sancti-johannis* is remarkable for the great reduction of the calcareous ring, the interradian pieces of which are fine filaments, and for the fact that the retractors of the pharynx are two-thirds the length of the whole body, and macroscopically, though not microscopically, seem to be tendinous for the greater part of their length. *Cuc. inconspicua* has the suckers almost, though not quite, regularly restricted to the ambulacral areas, and so affords an argument against the distinction of the species of *Cucumaria* into two genera, according as the suckers are confined to the ambulacra, or scattered over the body. *Holothuria inermis* is remarkable not only from the want of spicules, but also by the absence of the calcareous œsophageal ring; *H. secularis* has none of the turritiform spicules which are so generally present in the integument of the species of this genus.

Colochirus Lacazii.‡—M. E. Herouard describes a small Holothurian found near Roscoff at very low tide, which is interesting as being the first representative of this genus which has been found in European seas. It is white in colour and may reach a length of 70 to 80 centimetres. Its affinities with described forms are not pointed out.

Cœlenterata.

Regeneration of Polypes.§—Prof. M. Nussbaum reports that the continuation of his experiments confirms the experiences of Trembley. Arms of polyps cut off without any of the substance of the body attached always perish, but tentacles that retain ever so small a portion of the mouth-ring can form new polyps. This, he says, is owing to the absence in the tentacles of undifferentiated cells, which in the stomach portion replace the loss of the older and necessary tissues, and can be applied to the formation of the reproductive products.

Structure of Cunoctantha octonaria in adult and larval stages.||—Mr. H. V. Wilson gives an account of this medusa, whose larval existence in the bell-cavity of *Turritopsis nutricula* has been described by M'Grady and by Brooks. The history of the form does not seem to confirm Prof. Hæckel's idea that the difference between the Narcomedusæ and Trochomedusæ has been brought about by the migration of the tentacles from the umbrellar margin dorsalwards, for in *Cunoctantha* the four primary tentacles do not reach their ultimate position by a migration from the margin of the umbrella. Their final position is due to the outgrowth of intertentacular lobes, and to the growth of the velum, which fills up the interlobular notches, and then bends in to form the horizontal velum. The

* Jennaische Zeitschr. f. Naturwiss., xx. (1887) pp. 639-65 (1 pl.).

† Proc. Zool. Soc. Lond., 1887, pp. 531-4 (1 pl.).

‡ Comptes Rendus, cv. (1887) pp. 234-6.

§ Verh. Naturh. Ver. Bonn, xlv. (1887) pp. 10-11.

|| Studies Biol. Laborat. Johns-Hopkins Univ., iv. (1887) pp. 95-107 (3 pls.).

differences, however, are almost certainly of secondary origin, and due to the early development of the tentacles. It is impossible to place *Cunocantha* in any one of Hæckel's four families of the Narcomedusæ; the great German naturalist placed it with the Cunanthidæ, but, as it has no canal-system at all, it belongs rather to the Solmaridæ, from which, however, it is distinguished by the possession of otupupæ. In the shape of the true umbrellar edge it belongs to the Peganthidæ. The difficulties raised by this form, as by *Cunina proboscidea*, which Metschnikoff has shown to have otoporpæ and canals when produced from a fertilized egg, and no otoporpæ or canals when produced asexually, compel us to acknowledge that Hæckel's classification is so far unsatisfactory.

Origin of Male Generative Cells of *Eudendrium racemosum*.*—Mr. C. Ishikawa has investigated *Eudendrium racemosum* with the object of seeing whether the theory of Prof. Weismann that all sexual cells in the Hydromedusæ were primitively of ectodermal origin is correct. He finds that, in the males, the young germinal cells which are found in the endoderm of quite young gonophores, attached to the supporting membrane, are really derived from the ectoderm. In some fortunate sections the author was able to find the young on the outer side of the supporting membrane, lying in the ectoderm; in later stages they had disappeared therefrom, and were only found in the endoderm.

A young blastostyle of *E. racemosum* already carrying a number of gonophores with ripe sperm-cells exhibits the following appearance in transverse sections: in sections taken through the base of the gonophores groups of small rounded primitive germ-cells were found partly lying directly on the supporting membrane, and partly deeper among the endodermal cells. Nearer the base of the blastostyle (but still in its capitulum) sections reveal the presence of these cell-groups not only in the endoderm, but also in the ectoderm, where they lie directly on the supporting membrane. They are exactly similar to the primitive germ-cells found in the endoderm, and the author thinks there can be no doubt that they are primary male germ-cells which have not yet made their way into the endoderm. Mr. Ishikawa is not, however, able to say whether all the male cells are differentiated in the blastostyl from the ectoderm, and whether some are not formed in the stalk of the hydranth, from which the blastostyl is developed.

Polyparium and Tubularia.†—Dr. A. Korotneff gives a full account of the remarkable *Polyparium ambulans*, the preliminary description of which we have already noticed.‡ The following is the author's opinion as to the systematic position of this peculiar form.

The chief characters are the absence of tentacles, the presence of various oral cones which lead into a common cavity, but have no cesophageal tube, the apparent absence of radial septa, and the presence of peculiar septa which divide the body into segments. When we make a comparative survey of other Cœlenterates we find that in *Mæandrina* separate polyps, or rather oval cones, like those of *Polyparium*, are arranged in band-like fashion on the surface of a spherical polyp-stock; the chief difference between them is that the cones are more numerous in the latter. In *Mæandrina* the tentacles do not surround every oral orifice, but are placed along the margin of each band. It must be supposed that in *Polyparium* also the tentacles migrated to the margin, and afterwards became lost; such

* Zeitschr. f. Wiss. Zool., xlv. (1887) pp. 669-71.

† Ibid., pp. 468-90 (1 pl.).

‡ See this Journal, 1886, p. 627.

a disappearance may be partially explained by a change in the mode of life, for the creature is able to move about, and has not, therefore, the same need for tentacles as has a fixed form.

The number of mouths may be supposed to be due to division, and the absence of an œsophagus to each supports this view. The change has had its influence on the internal organization, the septa especially having undergone a fundamental modification. If we suppose that a polyp were to lose its œsophageal tube the septa would project freely into the gastric cavity; if, further, the primary were to divide into a number of secondary mouths, and the colony were to be greatly elongated, the radial arrangement of the septa would disappear. The free mode of life has not been without its influence; to produce the definite movements the parieto-basilar muscle has become transverse, and the corresponding septa have become altered into partition-like structures. Thus the radial type of a polyp may be easily converted into the bilateral.

From the same island of Billiton Dr. Korotneff obtained a new species of *Tubularia*—*T. parasitica*—which he found living on a Gorgonian. The head of the polyp had the ordinary structure, and the genital products presented nothing remarkable. In endeavouring to settle how the two forms could become as intimately connected as they are, it is necessary to remember that a hollow Gorgonian is not rare, while a one-stemmed Tubularian is a really exceptional case. It must, therefore, be supposed that it is the Tubularian which has undergone an adaptive change which has suited its form to that of the Gorgonian—the latter then was the original host, and the former the parasite. It is possible that an embryo fixed itself either to the end or to the side of a branch of the Gorgonian, and then, if at the end, made its way in by boring, possibly with the aid of an acid, to the internal axial cavity, where it commenced to grow; in the neighbourhood the mantle of the host would be more feebly coloured, and much fewer polypides would be developed. If the embryo fixed itself to the side there would be no need for it to bore its way in, and the *Gorgonia* would in time grow over the Tubularian.

Polyparium ambulans.*—Prof. E. Ehlers has some suggestions as to the characters of Dr. Korotneff's form (see *supra*). He calls attention to *Ricordea florida*, in which from single persons there are developed colonies with incomplete division of the several persons. He differs from Korotneff in regarding *Polyparium* as one person, and he thinks that it has tentacles, but no mouth—the mouth-cones not being mouth-orifices, but tentacles; the observations of Prof. R. Hertwig on the Actinaria of the 'Challenger' would support this view. If this be the right way of looking at the matter, the septa would be found to present no really abnormal characters. The most important question is raised when we come to discuss the phylogenetic origin of *Polyparium*, and the suggestion is made that it is a "paranomally" (as opposed to eunomally) developed animal, or one that, owing to the influence of external conditions, has departed from the typical mode of development, comparable to what is seen among fishes in the Leptocephalidæ. In fine, Prof. Ehlers is inclined to think that *Polyparium ambulans* is a mouthless single animal, derived from a unioral Actinian with wide degenerate tentacles, and that under the conditions of its life it has paranomally developed its band-like form; it may be able to reproduce itself asexually by fission. But Prof. Ehlers is careful to remark that his suggestions are made after reading Dr. Korotneff's paper only, and not after a personal examination of specimens.

Morphology of Siphonophora.*—Prof. C. Chun commences by discussing the structure of the pneumatophore, which is shown by recent observations to be certainly a modified Medusa. He denies the accuracy of Korotneff's statement that it contains any gastric cavity. The pneumatophore consists, as is well known, of two lamellæ, an outer one which represents the continuation of the trunk, and an inner one which excretes the air—this inner layer may be called the air-sac, and the outer one the air-umbrella. Both consist of ectoderm and endoderm separated by a supporting lamella. As the air-chamber is an invagination of the apical end of the trunk, its inner surface is lined by ectoderm. In all the species there is a constriction at the lower pole of the air-sac which may be called the air-funnel. The lining ectodermal layer early forms a flattened epithelium, and even in the embryo gives off a delicate chitinous lamella, which forms a ring at the orifice of the sac; this lining is, moreover, multilaminar; the cells bounding the air-space are small and filled by a finely granular protoplasm; the underlying vacuolated cells gradually diminish in size, and are so packed as to be polyhedral in form.

There are a number of variations in the structure of the air-funnel which appear to be characteristic of different species; the structure is simplest in *Apolesia uvaria*; the endodermal investment of the funnel and the lowest part of the air-sac consists of long cells radially arranged in groups; the ectodermal cells, which are separated from them by a delicate supporting layer, form a thick multilaminar cushion. Part of this forms a secondary investment over the chitinous ring, and it was this that Korotneff mistook for a secondary stomach. In *Stephanomia picta* (= *Halistemma tergestinum* Claus) the pneumatophore is provided with internal septa, and these are swollen at their base owing to the entrance between the endodermal of large ectodermal cells, which form a solid mass.

In *Physalia hydrostatica*, the structure of whose pneumatophore has never yet been completely understood, the number of septa varies, but is ordinarily seven; the so-called septal canals represent branched solid "cellular tubes" which are formed of ectodermal cells, and which make their way from the air-funnel between both the septa and the finely granular ectodermal cells which grow into the lower fourth of the air-funnel. They are the homologues of similar cells in *Stephanomia*.

The remarkable structure of the pneumatophore of *Rhizophysa filiformis* is due to the loss of the septa, while the ectodermal cellular cords between them persist.

With regard to the physiology of the several parts of the pneumatophore, it is clear that it is the function of the ectodermal lining and of the secondary ectoderm to secrete air; the latter is larger in proportion to the size of the organ—in *Physalia*, for example, it forms a disc as broad as the hand, though, strangely enough, it has never yet been noted by any observer. The taking in of air from without is only possible in the Velellidæ and Porpitidæ, where there are a number of air-pores; they have no secondary ectoderm or air-funnel, and their camerate pneumatopore is completely invested by a thick chitinous layer. Though *Rhizophysa* and *Physalia* have an air-pore, it serves merely for the egress, and not for the entrance of air.

In investigating the morphology of this organ it is necessary to inquire whether the pneumatophore is a characteristic of the higher Siphonophora, or whether it has its homologue in a medusoid appendage of the Calyco-phoridæ? Chun has shown that the definite nectocalyces of the latter are

* Zool. Anzeig., x. (1887) pp. 511-5, 529-33.

probably preceded by a heteromorphous primary bell, and it is this which he regards as the homologue of the pneumatophore of the Physophoridae. In other words: all Siphonophora have at the commencement of the trunk a heteromorphous medusoid appendage, which is after a time cast off by the Calyceporidae, while it persists in other Siphonophora as a pneumatophore.

New Scyphomedusæ.*—Dr. W. Haacke gives an account of the Scyphomedusæ which he collected and studied from the Gulf of St. Vincent. (a) *Charybdea* (*Charybdusa*) *rastonii* n. sp. is especially interesting on account of the structure of its sensory organs which differ somewhat from the typical *Charybdea*. (b) *Cyanea muellerianthe* n. sp., a southern representative of this beautiful genus. (c) *Monorhiza hæckelii* n. g. et n. sp. forming along with Lendenfeld's genus *Pseudorhiza* the important family of Chaunostomidae. Although both are certainly Rhizostomeæ with eight arms, it is peculiarly interesting that the Rhizostomatous condition is much restricted, so that they appear rather like Semostomeæ. In the genus described the Rhizostomatous condition was in the dozen specimens observed always restricted to one oral arm, which in contrast to the other seven exhibited a large, long and thick, three-cornered, terminal knob. This arm was always the left member of one of the four pairs. Young and adult specimens exhibited the same condition. The interest of this asymmetry is emphasized. Of three species, both young and adult forms are described at length. The memoir concludes with a faunistic chapter, in which the author discusses the geographical distribution. There are three coloured plates.

Anatomy of the Madreporaria.†—Dr. G. H. Fowler, in his third memoir on the anatomy of the Madreporaria, deals with *Turbinaria*, *Lophohelia*, *Seriatopora*, and *Pocillopora*. With regard to the first of these, the most important points that have been made out are that the polyps are of the normal actinian type, and are bilateral but not rigidly bisymmetrical; the septa, and, possibly, the tentacles are entocœlic only; the number of the septa is inconstant and bears no relation to any multiple of six; the general body-wall of the colony is supported upon the echinulations of the coenenchyme, but this may be a secondary arrangement, which has been acquired for the purpose of support, contemporaneously with and in consequence of the development of coenenchyme.

The polyps of *Lophohelia prolifera* are of the normal actinian type, save for the absence of directive mesenteries; this is, as yet, unique; its septa and tentacles are both ectocœlic and entocœlic, and, again, the number of septa are not necessarily a multiple of six; in the skeleton three series of centres of calcification are to be made out; of these, one lies in the theca itself; while the other two are at the summits of the ectocœlic and entocœlic septa respectively.

In *Seriatopora* the polyps are of the actinian type of structure; the septa are ecto- and entocœlic, and the body-wall is supported upon the echinulations of the coenenchyme. The tentacles are remarkable for undergoing introversion, but no special musculature for effecting the contraction could be detected. Of the twelve mesenteries six are of some length, and six are rudimentary.

Pocillopora brevicornis closely resembles *Seriatopora subulata* in anatomical structure, but the tendency towards the exclusive assumption of

* Jenaische Zeitschr. f. Naturwiss., xx. (1887) pp. 588-638 (3 pls.).

† Quart. Journ. Micr. Sci., xxviii. (1887) pp. 1-19 (2 pls.).

functions by six mesenteries is not so well marked; the polyps are monœcious.

In a concluding note, Dr. Fowler points out the logical fallacy of Dr. Koch's argument that the skeleton of *Flabellum* is an *epitheca*, and urges that there is nothing in the structure of its corallum which is really inconsistent with the idea that it is a theca.

Anatomy of *Mussa* and *Euphyllia*, and the Morphology of the Madreporarian Skeleton.*—Mr. G. C. Bourne gives an account of the anatomy of *Mussa* and *Euphyllia*, two genera of Madreporaria aporosa. In the former the soft tissues of the polyp extend downwards for a considerable distance on the outside of the corallum; so that there is a well-developed "Randplatte," and this contains extrathecal continuations of the exocoelæ and entocoelæ. The only point of divergence from the normal actinian type is the absence of directive mesenteries; this is the case also with *Euphyllia* and with *Lophohelia* (see Fowler, *supra*). The calicoblasts are either rounded or polygonal, or are drawn out into very long, narrow, columnar cells; the pyramidal or oval cells, which have been regarded by Sclater and v. Heider as calicoblasts, are always associated with the mesogloea of the mesenteries, and are, as Fowler suggests, connected rather with the attachment of the mesentery to the corallum than with the secretion of coral. *Mussa*, *Euphyllia*, and *Lophohelia* show no indication of bilateral symmetry, but are perfectly radial; this may be a primitive condition or may be connected with fissiparity. In *Euphyllia* the stomodæum is very long, and is converted into a ramifying and inosculating system of canals; the endoderm is greatly vacuolated, and becomes a reticulated tissue filling up the cœlenteron, in the meshes of which are numerous nematocysts and symbiotic algæ. In the stomodæal canals there are numerous fragments of vegetable matter; this observation is of interest, as it seems to be the first instance recorded of a coral feeding on a vegetable diet, and also as proving the digestive function of the enormously and peculiarly developed stomodæum.

The author suggests the following as the best provisional arrangement of the Madreporaria:—

- I. M. with no directive mesenteries and a perfectly radial symmetry—*Lophohelia*, *Mussa*, and *Euphyllia*.
- II. M. with directive mesenteries and a combined radial and bilateral symmetry—*Turbinaria*, *Rhodopsammia*, *Fungia*, &c.
- III. M. with reduced radial symmetry and marked bilateral arrangement of parts—*Madrepora*, *Pocillopora*, *Seriatopora*.
- IV. M. with a basal pseudotheca and no "Randplatte"—*Flabellum*.

The Madreporaria differ from the Alcyonaria in that the calcareous tissue is always external to the polyp; in the latter ectodermic cells become imbedded in the mesogloea and there develop spicules.

Porifera.

***Cladorhiza pentacrinus*.†**—Mr. A. Dendy describes a very remarkable Monaxonid sponge, which has a curious external resemblance to the pentacrinoid larva of *Antedon*. The sponge has a long slender stem, which terminates above in a subglobular body bearing a circlet of short pinnæ or

* Quart. Journ. Micr. Sci., xxviii. (1887) pp. 21-51 (2 pls.).

† Ann. and Mag. Nat. Hist., xx. (1887) pp. 279-82 (1 pl.).

arms; these curve upwards and inwards over the top. Below, the stem terminates in a number of very slender, long, branching rootlets. With the single exception of *Chondrocladia clavata* it is the smallest sponge known to the author, its total length being only 24 mm., of which the stem measures 11 mm. It was taken off the north-east of New Zealand, at a depth of 700 fathoms, and, like other deep-sea Monaxonids, it has a definite and symmetrical shape. The peculiar curvature of the pinnæ suggests that they may, during life, have the power of bending and unbending, but unfortunately the condition of the specimen did not admit of any investigation into the presence of those contractile fibre-cells, which Prof. Sollas has lately suggested should be called myocytes. Of the spicules, some of the microsclera are peculiar for the possession of three elongated, fang-like teeth at the small end of the spicule.

Protozoa.

Theory of Sexuality.*—M. E. Maupas sums up in a theory of sexuality the results of his recent beautiful observations on the conjugation of ciliated infusorians. It will be remembered that according to Maupas the micronucleus is a hermaphrodite sexual element, of sole importance in conjugation. In the stage (A) it increases in size; it then divides twice (B and C), and eliminates the "corpuscles de rebut." This effected, it divides again (D), differentiating a male and female pronucleus. In the next stage (E) the male elements of the two conjugating Protozoa are exchanged, and the new male nucleus fuses with the original female portion. In the next two stages (F and G) the nuclear dualism characteristic of the Ciliata is re-established (the old macronucleus having broken up and been eliminated meanwhile). In the last stage (H) the ex-conjugates reassume their original organization before dividing for the first time.

What is the meaning of all this? There is no special sexual reproduction or generation. There is no acceleration of division after conjugation. It is a period of risk, especially during the inertia of reconstruction. It is a loss of time. An *Onychodromus grandis* had from 40,000 to 50,000 descendants while a pair were indulging in a single conjugation. It is a source of destruction, not of the multiplication of individuals.

The riddle was solved by a long series of careful observations. In November 1885 M. Maupas isolated a *Stylonychia pustulata*, and observed its generations till March 1886. By that time there had been 215 fissiparous generations. But at that time the colony gave in; the individuals had lost the powers of nutrition and reproduction. Individuals removed at various stages, however, had conjugated with members of different origin. The same experiment was repeated with other forms. In March 1886 an ex-conjugate from one of the couplings just referred to was removed and watched till the 10th July, when the family again gave in. During that time 315 divisions had been observed. Numerous conjugations had been effected with members removed to other families. This was done till the 130th generation, and till then all the conjugations were fertile. About the 180th generation individuals of the same family which had not hitherto been in contact with one another began in despair to conjugate. The results were, however, *nil*; the conjugates did not even recover from the effects of their forlorn hope. Other cases are related.

The result is evident. The process is essential for the *species*. The life runs in developmental cycles of multiplication by division, which are strictly limited. If conjugations with unrelated forms do not then occur

* Comptes Rendus, cv. (1887) pp. 356-9.

the life ebbs. The sexual conjugation of the Ciliates is thus a rejuvenescence, as Bütschli and Engelmann maintained. It is essential as a reorganization of the nucleus. After a prolonged series of divisions the nucleus undergoes senile degeneration. Without conjugation death would be inevitable. The death is a natural one, the occurrence of which some would deny. Sexual conjugation is the necessary condition of their "eternal youth and immortality."

New Infusoria.*—Prof. D. S. Kellicott describes four new species of Infusorians:—(1) *Podophrya inclinata*, spherical in young, pyriform in adult stages; sub-central spheroidal nucleus; rarely more than two small, slowly pulsating contractile vacuoles; few slightly capitate tentacles; curved pedicel, narrowed towards fixed base; on swimming feet of *Cambarus* from Magara river. (2) *Podophrya flexilis*, sub-spherical, plastic, with many granules in larger specimens; sub-central, ovoid, granular nucleus; single, anterior, slowly pulsating contractile vacuole; two to four, extensile, apparently capitate tentacles; short pedicel; on pedicels of *Epistylis digitalis* on *Cyclops*. (3) *Carchesium granulatum*, elongate, sub-cylindrical, slightly constricted below thickened peristome border; rows of cuticular elevations; moderately elevated, convex, tumid ciliated disc; long, twisted, longitudinal nucleus; two contractile vacuoles, slowly and alternately pulsating; pedicels dichotomously branched without septa; on *Cambarus* and plants. (4) *Opercularia humilis*, fusiform, transversely striated; U-shaped transverse nucleus; low contractile vacuole; peristome border thickened and slightly dilated; narrow, convex, moderately elevated lid; ample cilia; slightly elevated collar; very short pedicel; on *Gammarus* and Entomostrea; also notes on *Lagenophrys discoidea* and *Gerda sigmoides*.

New Fresh-water Infusoria.†—Dr. A. C. Stokes describes (1) *Anthophysa stagnatilis*, the colonies of which may consist of more than fifty zooids; its pedicle does not branch distinctly, the nucleus is placed in the posterior part of the body, and the contractile vesicle is near the centre of the same region. (2) *Hexamita gyrans* appears to carry the contractile vesicle along the course of its semifluid endoplasm; this vesicle appears to expand when near the posterior extremity, and to contract and disappear near the anterolateral border. (3) *Chloromonas pulcherrima* has irregular and vacillating movements. (4) *Balanitizoon gyrans* executes movements by rapid revolutions on its longitudinal axis, with sudden lateral leaps; it is reproduced both by transverse and longitudinal fission. (5) *Gerda vernalis* was taken from beneath ice a quarter of an inch thick, but was quite lively. (6) *Rhabdostyla vernalis* has a shorter pedicle, and a more posteriorly placed contractile vesicle than *R. invaginata* Stokes; it is reproduced by longitudinal fission and by encystment; the former takes place rapidly, the body widening until the breadth is nearly equal to the length; it then divides into two longitudinal parts, the half which will finally develop an independent pedicle remaining attached to the original foot-stalk by the tip of its posterior extremity until it has produced a ciliary girdle, by means of which it swims about freely for a short time. In encystment the animalcules remain quiescent and unchanged for an indefinite and unknown time. (7) *R. chæticola* was found attached to the dorso-lateral setæ of *Nais*. (8) *Vorticella similis* has considerable resemblance to *V. patellina* Müll., but differs, not only in its fresh-water habitat, but by its striated surfaces, revolute edge to the peristome, and much smaller size. (9) *V. vernalis* belongs to the group in which the surface is ornamented by cuticular monilations, but is distin-

* Microscope, vii. (1887) pp. 226-33 (4 figs.).

† Amer. Mon. Micr. Journ., viii. (1887) pp. 141-7.

guished from all known forms by the combination of rounded prominences and transverse striations. (10) *V. parasita* was found attached to the body of an aquatic worm. (11) *V. conica* has a much elongated body, and when contracted exhibits posterior annulations. It appears to be much less timid than most *Vorticellæ*, for the cover-glass may be repeatedly and somewhat violently disturbed without in any way altering the expanded animal; this may be explained as due to the activity of the supporting host, for the *Cyclops* leaps through the water with rapid and often long-continued movements. (12) *Epistylis tinctoria* resembles *E. flavicans* somewhat closely in some of its characters, but differs in having the contracted zooids pyriform and not subspherical in shape, and the ultimate divisions of the pedicle more than twice as long as the expanded bodies. In the hinder part of the bodies of most representatives of this new species there was a cluster of refractive and apparently crystalline bodies, the nature of which is quite problematical; they often occur in young colonies composed of only two zooids, and are absent from older zooidendria formed of many. (13) The last new form is *Lagenophrys obovata*, which in form and size most nearly resembles *L. vaginicola*, but differs from it in the less cordate aspect of the lorica, and the narrower anterior region. A woodcut is given illustrating these forms.

New Hypotrichous Infusoria from American Fresh Waters.* — Dr. A. C. Stokes describes as a new genus *Onychodromopsis*, which differs from *Onychodromus* chiefly on account of the soft, flexible, and uncuriassed condition of the body. On the dorsal surface there are numerous short, hispid setæ; *O. flexilis* is the new species. *Tachysoma agile* is the type of a new genus which is distinguished from *Pleurotricha* by the absence of the supplementary ventral series of styles, and the softness and flexibility of the body; these latter characters, with the absence of caudal setæ, distinguish it from *Stylonychia*, which it otherwise somewhat closely resembles; as it has the marginal setæ of the posterior border interrupted it cannot be placed with *Oxytricha*; its systematic position is probably between the last-named genus and *Histrio*; *T. mirabile*, and *T. parvistylum*, are the other new species of the genus. The other new species described in the paper are *Litonotus vermicularis*, which may be 1/60 to 1/30 in. long, and the largest and mature forms are visible to the naked eye as fine white threads gliding through the water; *Loxodes magnus*, which is 1/40 in. long; *Oxytricha bifaria*, *O. hymenostoma*, *O. acuminata*, and *O. caudata*; *Histrio inquietus* and *complanatus*; *Euplotes variabilis*; and *Chilodon vorax*, as to which we have the following very interesting account:—

“The infusorians under observation fed voraciously on certain linear diatoms (probably a species of *Nitzschia*), with which the water teemed, the frustules often being considerably longer than the body of the animalcule in its normal condition, and after being engulfed, consequently, extending through the entire length of the infusorian, and stretching the cuticular surface at both extremities until at these points the limiting membrane became the merest film. Before the process of engulfing was actually witnessed, it was an interesting problem as to how the diatom became freed from the posterior region of the pharyngeal passage which extends almost to the centre of the body. . . . During the passage of the frustule, when the cuticular surface of the rear margin of the body has reached its limit of extension, the pharyngeal tube, containing one end of the long diatom, suddenly and violently rotates forward until its normal position is completely reversed, and the diatom consequently slips out. The act is probably only to a certain extent voluntary, being effectually

* Ann. and Mag. Nat. Hist., xx. (1887) pp. 104-14 (1 pl.).

aided by the strong pressure from the extended cuticular surface, which tends to force the pharyngeal fascicle forward."

Development of fresh-water Peridineæ.*—M. J. Danysz comes to the conclusion that there is great uniformity in the developmental history of widely separated genera of Peridineæ, and is of opinion that these forms should be associated rather with plants than animals.

The following seem to be the successive stages:—Active individuals multiply by successive fissions, and become smaller and smaller. Notwithstanding the great differences in the structure of the body and of the nucleus, the process of division is identical in all; it is always effected along the longitudinal axis of the body, the line of separation being a little oblique to the transverse axis. Phases of multiplication similar to those seen in active forms are to be observed in individuals, which, owing to the liquid which contains them being less fluid than pure water, are in a state of repose. The author thinks that the cause of this phenomenon is purely mechanical. The conditions which M. Danysz looks upon as those of fission were regarded by Stein as states of conjugation. The period of multiplication is followed by that of spore-formation, which has been followed in *Gymnodium musci* D. and *G. glaciale* sp. n.

The spores are spherical bodies quite unlike their mother-cells; the protoplasm is covered by two membranes, the outer of which is thick, and formed of two layers of different chemical properties, while the inner is delicate and hyaline; the protoplasm, which is finely granular, contains a large number of various kinds of corpuscles; these are very small chromoleucytes which are scattered through the bodies of active individuals and localized into one or several corpuscles in the cysts; when these are differently coloured, those of distinct colours separate from each other. Drops of oil and of fatty bodies in the solid state, which are probably due to the transformation of starch or granulose, are either found scattered irregularly, or arranged in order in the protoplasm of the spore. The inner lamella of the outer range appear to be pure cellulose, while the outer lamella is probably chitinized cellulose. The inner hyaline layer appears to be the membranous layer of the protoplasm.

Reproduction of Euglypha.†—Dr. F. Blochmann describes experiments which supplement Gruber's observations on the division process amongst shell-bearing fresh-water Rhizopoda, which showed that these forms multiply by a budding process. The bud is covered with shell plates as it is formed, and a division of the nucleus occurs at the same time. Separation usually occurs when the bud has reached the size of the parent; but Dr. Blochmann observes that, in very many cases, further changes before separation end in the death of the budded off portion, so the process results in no multiplication of individuals. A drawing back of the protoplasm into the original shell leaves the new one empty of all but the young nucleus, which had been pushed into it. This nucleus remains attached to the base of the new shell, and evidently dies as soon as the protoplasm becomes separated from it. Now either of two things may happen. The shell and dead nucleus may fall off together; or the dead nucleus may again be drawn into the original shell—a pseudopodium flowing round it, and holding it for a time, but ultimately again extruding it. No change in the individual was noted after this curious phenomenon, which Dr. Blochmann compares to the extrusion of polar bodies from the eggs of Metazoa. He thinks a similar process was mistaken by Jickeli for

* Comptes Rendus, cv. (1887) pp. 238-40.

† Morphol. Jahrb., xiii. (1887) pp. 173-83 (1 pl.).

conjugation in *Diffugia globulosa*. He further describes cases of actual conjugation in *Euglypha*, and enumerates the points by which these can be distinguished from cases of division. The individuals, after conjugation, either divided or encysted in the manner which Gruber describes; but, in one instance, two conjugated *Euglyphæ* formed one large one, which included the protoplasm and fused nuclei of both elements, and which finally encysted.

Planispirina.*—M. C. Schlumberger describes the three most important species of the genus *Planispirina*, whose dimorphism has not yet been noticed: they are, *P. sigmoidea* Brady, *P. celata* Costa, and *P. edwardsi* n. sp. He next proceeds to discuss the opinion of Mr. H. B. Brady as to the generic distinctiveness of these and some allied forms, and, contrary to the judgment of that naturalist, comes to the conclusion that the mode of disposition of the chambers of their tests is sufficiently characteristic to justify the creation of a new genus, for which M. Schlumberger proposes the name of *Sigmoilina*.

New Parasitic Rhizopod.†—M. A. Giard finds that at Concarneau, and especially at Fécamp, the *Cancerilla*, which is parasitic on *Amphiura squamata*,‡ has on its own carapace a fine parasitic Rhizopod. This, which may be called *Podarcella Cancerillæ* g. et sp. n., is a pedunculated Arcellid. The peduncle adheres to the cephalothorax of the host by a small discoidal expansion; it is once and a half as long as the funnel-shaped cupule which terminates it, and, like it, it is formed of a substance which is apparently chitinous. The amœboid body moves slowly in this cupule.

Amœbæ of Variola vera.§—Dr. A. van der Loeff placed some pock matter taken from two persons suffering from confluent small-pox in sterilized tubes, and examined it on the evening of the same day in hanging drops. The same corpuscles—Proteidæ or *Amœbæ*—were found in large numbers and of various configuration, as were found by the author in fresh animal lymph. Even in cover-glass preparations the *Amœbæ* could be easily recognized after staining with fuchsin.

Protozoa of the Black Sea.||—Miss B. Peréraslvtzéva has endeavoured to make the list of Black Sea Protozoa more approximately complete. The memoir includes a list of 100 species. Of these 18 are new, and are described and carefully figured. The author has also sought to test the accuracy of the generalizations formulated by Merejkowski in regard to the geographical distribution of the Protozoa, and has been forced to refute them.

Parasites in the Blood.¶—Prof. B. Danilewsky concludes his study of the hematozoic parasites of the tortoise. In investigating the different organs, he found but little of importance in the spleen or kidney, except that in the latter he detected the presence of the Gregarinoid spores in the pseudonavicella stage. The study of the medulla in the bone-cavities yielded valuable results, especially in young tortoises. In this tissue the hæmo-Gregarinid parasites are extremely abundant in all stages of development—young, adult, and free. The various forms are described in detail. The investigation of the marrow was the more important since Bizzozero and Torre have maintained that this tissue is in the tortoise the sole seat of the manufacture of red blood-corpuscles. In the hæmatoblasts, as was to

* Bull. Soc. Zool. France, xii. (1887) pp. 475-88 (1 pl.).

† Comptes Rendus, civ. (1887) p. 1191.

‡ See this Journal, ante, p. 537.

§ Monatshefte f. prakt. Dermatol., 1887.

|| Mém. Soc. Néo-Russ. Natural. Odessa, x. (1886) p. 2 (3 pls.). Cf. Arch. Slav. de Biol., iv. (1887) p. 116.

¶ Arch. Slav. de Biol., iii. (1887) pp. 370-417.

be expected, abundant hæmatozoic embryos were found. In the same region Prof. Danilewsky also observed within the corpuscles oval masses, which divided by a process of (muriform) segmentation (hardly to be described as sporulation) into a number of embryos. In other cases the minute embryos were seen apart, evidently liberated from a ruptured cytocyst.

According to the author, each corpuscle containing a hæmogregarine parasite, has received the latter from a hæmatoblast. The hæmatoblast may itself have engulfed a germ, or may have received it from a leucocyte.

Germes originating from a spore-forming Gregarine in some part of the alimentary canal or urino-genital ducts may readily become included in the leucocytes. In the interior of the latter the germ undergoes a solitary and progressive development, while the containing cell is transformed into a blood-corpuscle. In this intracellular life the parasite passes through the stages which in the normal history of Gregarines are known as primitive germ, pseudonavicella, falciform body, and mobile adult. In contrast to the usual history the hæmogregarine develops within the corpuscle from an almost imperceptible germ to maximum size, and that at the expense of extrinsic nutritive material. There is a certain parallelism, not without exceptions however, between the blood-corpuscle and the included hæmogregarine. The presence of the parasite does not appear to affect the vitality of the developing blood-corpuscle.

As to the mode of introduction into the tortoise, Prof. Danilewsky is inclined to regard the alimentary canal as the most probable entrance, and there is no doubt that in the insects, myriopods, &c., eaten as food, there is an abundant source of supply for Gregarinoid parasites.

New Parasite of the Pock-process belonging to the Sporozoa.*—Dr. L. Pfeiffer has found a coccidia-like parasite which, in company with fungi and bacteria, lives in the pocks of various mammals and of man, and passes its first stages in the epithelial cells of the rete Malpighii: in this respect it would agree with the coccidia inhabiting epithelia (e. g. *Coccidium oviforme* Leuck.). The author found it very frequently in sections through the rete, partly in layers, partly within the epithelial cells, which were swollen up by the growth of the spherical parasites and finally destroyed. The smallest examples are 0.009 mm. large, and show a bright nuclear-like spot about 0.005 mm. in size. Like *Coccidia*, this *Monocystis epithelialis*, as the author calls it, forms a thick sheath, the original capsule is thrown off and a new one formed. Several examples are rarely found in one cyst. After incapsulation sporulation begins. The spores which are found in quantity in the lymph appear to pass directly into amœboid, slightly mobile embryonic bodies. The author regards the transparent blood-corpuscle-like discs as the young condition of the parasite, and is disposed to think that the entrance into the epithelial cells is perhaps not necessary for its development, as the parasites are found free in the protoplasm of the vesicles, and as it is possible to breed and propagate them in the artificial media up to the third generation.

* Correspondenz-Blätter allg. ärztl. Vereins v. Thüringen, 1887, No. 2, 12 pp. (2 pls.).

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.*

(1) Cell-structure and Protoplasm.

Morphological and Chemical Composition of Protoplasm.†—In this very exhaustive treatise Herr F. Schwarz enters into great detail with respect to the behaviour of the different constituents of the protoplasm of the vegetable cell with various reagents; only the more important results can be indicated here.

The varying acid or alkaline reaction of the cell-sap in different cases he attributes to the pigments or other substances contained in solution in it; in no case has he found the protoplasm to have an acid, but in most cases a distinctly alkaline reaction; and this applies equally to the cytoplasm, the nucleus, the chromatophores, and the microsomes, and in some cases also to the protein-grains. This alkaline reaction is not due to the presence in the protoplasm of ammonia or other free alkalies, but probably to alkaline salts, especially phosphates, combined with the albuminoids in the living cell.

The author regards the chlorophyll-bodies as having a fibrillar structure; the fibrillæ do not, however, form a network, but lie side by side, filling up the entire mass of the chlorophyll-body. The fibrillæ, composed of a substance which he calls *chloroplastin*, are not uniform in colour, but contain globular bodies of a deeper green than the rest, the vacuoles or "grana" of Meyer; between the fibrillæ is a colourless substance, the *metaxin*. These two components of the chlorophyll-bodies can be separated by the action of water, in which the fibrillæ swell up strongly, but are entirely insoluble, while the metaxin is finally completely dissolved. They may also be distinguished by other chemical reactions.

As components of the nucleus, Schwartz distinguishes the following substances:—(1) *chromatin*, the portion most sensitive to staining, occurring in the form of larger or smaller globules or granules, the "nucleo-microsomes" of Strasburger; (2) *pyrenin* and *amphipyrenin*, which constitute, respectively, the body and the membrane of the nucleus; these differ widely in their reactions from chromatin, and from one another, the former taking up staining reagents much more readily; (3) *linin* and *paralinin*, the substance respectively of the nuclear threads, the "nucleo-hyaloplasm" of Strasburger, and of the intermediate matrix or "nuclear sap." The behaviour of these various substances towards different reagents is given in great detail.

The cytoplasm has, as a rule, no reticulate or fibrillar structure; though in *Spirogyra* and some other cases a certain amount of differentiation does occur. It is made up of three distinct substances:—the substances dissolved in the vacuoles or cell-sap; the *microsomes*, insoluble both in water and in the cytoplasm; and the mucilaginous constituent or *cytoplastin*; this is the only proteinaceous substance invariably found in the cytoplasm, except in the youngest cells. The chemical properties of these various ingredients are again gone into in great detail. The formation of vacuoles the author regards as the result of the separation of substances previously combined, the more soluble of these collecting in the form of drops within the less

* This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents; (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

† Cohn's Beitr. z. Biol. d. Pflanzen, v. (1887) pp. 1-244 (8 pls.).

soluble. The membrane which bounds the cytoplasm outwardly and inwardly is not distinguishable chemically from the rest of its substance, and is formed out of the cytoplastin. The cytoplastin is coagulable by hot water, but is altogether insoluble in it.

The following is a summary of the more important chemical reactions of the substances above described:—The plastins (chloroplastin and cytoplastin) are insoluble in concentrated potash-lye and in a 10 per cent. solution of sodium chloride; while all the nuclear substances are soluble in these reagents; the plastins are not digested either by trypsin or pepsin, while the nuclear substances are all dissolved, at all events by trypsin. Chloroplastin is distinguished from cytoplastin by swelling up strongly with a 1 per cent. solution of hydrochloric acid, by which the latter is precipitated; chloroplastin is insoluble, or swells up slightly in a 5 per cent. solution of sodium phosphate, in which cytoplastin swells up strongly or is entirely dissolved.

Among the nuclear substances, chromatin and pyrenin are distinguished by their great absorptive power for pigments; their respective solubility differs with various reagents; chromatin is rapidly, pyrenin only very slowly digested by trypsin. Amphipyrenin absorbs pigments much less rapidly than pyrenin; it dissolves with difficulty in a 10 per cent. solution of sodium chloride, while pyrenin is readily soluble in it; on the other hand it is soluble in a 1 per cent. solution of potash-lye, pyrenin only with difficulty. Linin and paralinin are distinguished by their strong power of swelling with various substances, including water: paralinin is digested by pepsin, while linin is not. Metaxin is distinguished from the plastins by being digested by pepsin and trypsin; and from the nuclear substances by swelling up or dissolving in a 1 per cent. solution of sodium chloride, in which the latter are completely insoluble.

Position of the Nucleus in Mature Cells.*—Observations made by Herr G. Haberlandt lead him to the conclusion that the position of the nucleus in mature cells is not arbitrary, but depends on its function as the bearer of the idioplasm which governs development, this idioplasm being invariably seated in the nucleus.

When any particular wall or part of a wall is more strongly thickened than the rest, the nucleus is usually in immediate contact with this wall, and is sometimes connected with it by a string of protoplasm. A good example of this is the aquiferous epidermis of many orchids, where the nucleus is usually in contact with the outer wall. In other cases, when the inner wall is the thickest, it is in contact with it. In the guard-cells of stomata it is invariably in apposition with the thickened ventral walls. The rule is strikingly exhibited also in cells containing cystoliths. In the branching palisade-tissue of some *Ranunculaceæ* and of *Sambucus*, the nucleus has a central position, and is connected with the thickened portions of the wall by strings and plates of protoplasm.

In young roots (*Pisum sativum*, *Triticum vulgare*) the root-hair originates from a protuberance of the portion of the wall immediately over the nucleus, or the young root-hair is connected with the nucleus by one or more strings of protoplasm. In branched hairs it lies in their basal portion.

In multinucleated unicellular plants (*Saprolegnia*, *Vaucheria*), branches always originate immediately over a nucleus placed close against the cell-wall. The process of regeneration which takes place in many species of *Vaucheria* is always intimately connected with the presence of at least one nucleus.

* Ber. Deutsch. Bot. Gesell., v. (1887) pp. 205–12.

Albumen in the Cell-wall.*—Herr F. Krasser, following up the observations of Wiesner† on the presence of albuminoids in the cell-wall, discusses the value of the reagents at present used to determine the presence of albuminoids. He finds that they fail in either not staining all albuminoid substances, or they stain not only albuminoids, but also other substances resulting from their decomposition. This is the case even with Millon's reagent, which colours also tyrosin, hydroparacumaric acid, and phenol. The copper test, and sulphuric acid containing molybdic acid, are the least reliable of any. A new test for albuminoids is proposed, viz. alloxan.

As regards special tissues, in a very large number of plants examined, the author was unable to determine with certainty the presence of albuminoids in the cell-wall, either in the growing point of the stem or in the root. None was found in the cell-walls of the root-cap, while those of the cambium, pericambium, and phellogen were strongly coloured. In all the cases examined—sixty-two in number—the cell-walls of the epidermis gave the albuminoid reaction. This was also commonly the case with the elements of the soft bast; less often with those of the fundamental parenchyma and pith. In ten cases a positive result was obtained with collenchyma. With the endosperm the result varied in different cases.

As regards the source of the albuminoids found in the cell-wall, Herr Krasser comes to the conclusion, from the phenomena connected with its development, that they are not the result of infiltration, but have been formed in the course of its formation.

Permeability to air of Cell-walls.‡—By the use of the air-pump Herr E. Lietzmann has investigated the extent to which cell-walls, in various conditions, can become permeated with atmospheric air, carrying out the subject especially from a mathematical point of view. The objects specially examined were cork, lamellæ from the tissue of the leaf of *Peperomia magnifolia*, and lamellæ of the wood of *Pinus Laricio* and *P. sylvestris*.

With the pressures employed, cork was impermeable in the axial direction, while the cuticle of *Peperomia*, the walls of the tracheids of *Pinus*, and other cell-walls, were permeable. All cell-walls on which experiments were made were more permeable to air in a saturated than in a dry condition. The wood of *P. Laricio* was more permeable in the tangential than in the radial direction. In *P. sylvestris* open tracheid-bundles were met with as long as 22 centimetres, or perhaps longer. The living parietal utricle of protoplasm is altogether impermeable, or permeable only to a very slight degree.

Swelling and Double Refraction of Cell-walls.§—Herr S. Schwendener discusses this subject from an experimental and mathematical point of view. He agrees rather with the older view of Nägeli than with that of v. Höhnell, believing that the phenomenon in question is accompanied by shortening in the direction of one axis as well as by lengthening in that of another, as is shown by certain lines on the membranes. When the conditions of elasticity in the direction of these lines are different from those in a vertical direction, torsion must result. The phenomena connected with swelling are described in detail in the case of static-mechanical cells, of dynamic cells (bastlike stereids with transverse cleft-shaped pores), of cork-cells with cellulose-thickenings, and of the elongated cells of *Caulerpa*.

* SB. K. Akad. Wiss. Wien, xciv. (1887) pp. 118–55.

† See this Journal, 1886, p. 818.

‡ Flora, lxx. (1887) pp. 339–86 (1 pl.).

§ SB. K. Preuss. Akad. Wiss. Berlin, xxxiv. (1887) pp. 659–702 (4 figs.).

|| See this Journal, 1883, p. 90.

In connection with the relationship between swelling and double refraction, the author agrees with Zimmermann's statement* that all non-cuticularized cell-walls show such optical properties as if they were compressed in the direction of the strongest capacity for swelling, or with that of the strongest shrinking when dried; the strongest swelling takes place in the direction of the shortest axis of the ellipsoid of elasticity, the least in that of the longest axis, and a medium degree of swelling in that of the medium axis. This is shown in the cases of ordinary bast-cells with longitudinal pores, of specific dynamic cells, of dynamic hairs and pappus branches, of thick-walled cork-cells, and of *Caulerpa*. Molecular tensions, such as those assumed by v. Höhnelt, do not occur in any direction, and the hypothesis that double refraction in starch-grains or cell-walls is caused by such tensions must be abandoned. Such double refraction is dependent on a different arrangement in different directions of the minutest particles (molecules or micellæ) of the substance. The author accepts, with some limitation, Nägeli's conclusion of the absence of optical susceptibility of cell-walls to traction or pressure. This is especially true of normal stereids.

With regard to any change in the optical properties of the cell-wall resulting from the imbibition of fluids, the author's experiments gave negative results.

Silicified Cells in *Calathea*.†—Dr. H. Molisch describes peculiar cells in the bracts of *Calathea Seemannii*, surrounding the vascular bundles, especially the bast-cells, completely filled by silica, or possibly by a silicate. They occur in such numbers as to form a complete coat of mail around the vascular bundles. The walls of these cells are not silicified.

(2) Other Cell-contents.

Structure of Chlorophyll-grains.‡—From an examination of the small chlorophyll-grains containing very large "grana," in the creeping stem of *Goodyera (Hæmaria) discolor*, Herr V. Chmielewsky confirms Schimper's and Meyer's hypothesis that the matrix (stroma) of the chloroplast is colourless, the colour residing only in the vacuoles or "grana."

He was also able to follow out accurately the development of the starch-grains. As these are being formed the chlorophyll-grain gradually increases in size, while its grana diminish; and finally the entire chlorophyll-grain, with its grana, altogether disappears. In mature starch-grains not the least protoplasmic remains of the chlorophyll-grain can be detected. The first layer of the starch-grain is formed on the periphery of the chlorophyll-grain, from where it gradually extends to the interior.

Hourly Variations in the Action of Chlorophyll.§—M. J. Peyrou, with the aid of a new instrument which he has lately had made, has investigated the variations in the action of chlorophyll. He finds that the function, at different hours of the day, is proportional to the intensity of the light. His experiments were always made with an atmosphere saturated with moisture in the case of terrestrial plants. Corresponding results were obtained with aquatic plants.

Starch-grains coloured red by Iodine.||—Herr A. Meyer replies to Dafert's contribution on this subject, whom he charges with inaccuracy and confusion on the chemical side of the question. He epitomizes the

* See this Journal, 1885, p. 476.

† Verhandl. Zool.-Bot. Gesell. Wien, xxxvii. (1887) pp. 30-1.

‡ Bot. Centralbl., xxxi. (1887) pp. 57-9 (1 pl.).

§ Comptes Rendus, cv. (1887) pp. 240-3, 385-8.

|| Ber. Deutsch. Bot. Gesell., v. (1887) pp. 171-81. Cf. this Journal, ante, p. 424.

difference in the chemical and physical properties of starch-substance and amyloextrin; and states that none of the dextrins resulting from the action of ferments or acids on starch-substance are coloured by iodine. Erythro-dextrins do not exist; even dextrins of high rotating power can be so completely purified that they are no longer coloured by iodine. A dextrin can be produced for which (α) $D = 194.8$, and which is nevertheless not coloured by iodine. Where the red colouring is exhibited, it results from an admixture of amyloextrin.

Proteinaceous bodies in Epiphyllum.*—Herr. V. Chmielewsky has reinvestigated the bodies found by Molisch in the parenchymatous and epidermal cells of the branches of *Epiphyllum (truncatum)*, and corrects his description in one respect, stating that they are insoluble in alcohol. From their chemical reaction he regards them as of the nature of globulin, and believes them to be excretory rather than reserve-substances. He finds them in quite as large quantities in old as in young branches, and also that they are not used up when the plant is starved.

Carrotene in Leaves.†—M. A. Arnaud states that carrotene is always found in the leaves of plants in full vegetation. The amount is equal on an average to about 0.1 per cent. of the weight of the dried leaves, and it must exert a considerable influence on their colour.

Calcium oxalate in Aleurone-grains.‡—According to Herr A. Tschirch, the crystals of calcium oxalate found in aleurone grains of seeds are sometimes again completely dissolved when the seeds germinate, showing that they must have a function as reserve food-materials. This is especially well seen in the lupin. Herr Tschirch also describes the various crystalline forms which the calcium oxalate assumes in the aleurone-grains of seeds.

Nitrates and Nitrites in Plants.§—Dr. H. Molisch states that nitrates occur more abundantly in herbaceous than in woody plants, while in no single instance has he been able to detect the presence of nitrites, which are injurious to plants even in very dilute solutions, and are reduced by them with extraordinary rapidity. Nitrates can, on the other hand, remain weeks, or even months, within the cells of plants without being decomposed. The nitrates found in plants are never the result of the oxidation of nitrites or of ammonia salts in the cells, unless under the influence of bacteria, but are always absorbed as such from the soil.

Biological Import of Raphides.||—Prof. E. Stahl calls attention to the less obtrusive protective features exhibited by many plants. Numerous points of external and internal structure are, he maintains, only fully understood when considered in relation to the fauna which would destroy the plants if not in some way protected. At present, however, he only notes that the abundant raphides in plants are not wholly to be regarded as useless excretions, but also as protections against snails and other destructive foes, which are at least thus restricted in their ravages. Snails have been observed to confine their voracity to those parts of certain plants where crystals were absent. *Arum maculatum*, usually regarded as poisonous, owes its burning and repulsive taste solely to the presence of very numerous raphides which penetrate the mucous membrane of the mouths of those animals which attempt to devour it.

* Bot. Centralbl., xxxi. (1887) pp. 117-9 (1 pl.). Cf. this Journal, 1886, p. 89.

† Comptes Rendus, civ. (1887) pp. 1293-6. Cf. this Journal, 1885, p. 670.

‡ SB. Gesell. Naturf. Freunde Berlin, April 19, 1887. See Bot. Centralbl., xxvi. (1887) p. 223.

§ SB. Akad. Wiss. Wien, May 5th, 1887. See Bot. Ztg., xlv. (1887) p. 454.

|| Jenaische Zeitschr. f. Naturwiss., xx. (1887) pp. 145-7.

(3) Secretions.

Secretion of *Araucaria*.*—MM. E. Heckel and F. Schlagdenhauffen have demonstrated an interesting fact in regard to the secretion of *Araucaria*. The secretions of Conifers are known to be oleoresins, consisting of an essential oil and of a resin. But in the section *Araucariæ*, it would appear that the secretion is not a resin nor an oleoresin, but a resinous gum. The observations proving this interesting exception were made on a large number of *Araucarias*, so that the fact may be safely affirmed as true of the genus. The chemical investigations, the details of which need not be repeated, were based especially on the exudations of *Araucaria Cookii* R. Br. It is interesting to find a distinct genus thus marked off by chemical as well as morphological peculiarities.

(4) Structure of Tissues.

Aquiferous Tissue in the Leaves of *Sansevieria*.†—A similar function to that of the peculiar structures in the roots of austral Coniferæ is, according to Prof. F. W. C. Areschoug, exercised by certain cells with fibrous thickenings in several species of *Sansevieria*. Almost the whole of the internal fundamental tissue of the very thick leaves is transformed into aquiferous tissue, except a portion immediately surrounding the vascular bundles. The cell-wells of this tissue are very thin and porous, the pores having the form of a flat ring. The whole of the inner surface, even of the horizontal walls, is covered by slender branching fibre-like thickenings arranged spirally, which prevent them from contracting, so that they may serve as a perpetual reservoir of water.

Laticiferous Vessels and Assimilating System.‡—From an examination of the orders Apocynaceæ, Asclepiadæ, Euphorbiaceæ, Campanulaceæ, and Lobeliaceæ, Sigg. J. R. Pirota and L. Marcatilli endeavour to trace the relationship between the laticiferous vessels and the assimilating tissue in the leaves. They find that, in the greater number of cases, the laticiferous vessels follow the course of the veins, and form in the leaves a more or less close network. In other cases they leave the veins and spread through the mesophyll. In all cases the authors believe that the laticiferous vessels are so arranged as to receive the products of assimilation from the parts where they are elaborated and transport them to the different parts of the plant.

Sieve-tubes.§—Dr. A. Fischer defines a sieve-tube as active so long as, on making a section of the living plant, it forms "Schlauchköpfe," i. e. so long as the sieve-pores are open and the contents fluid. Of active sieve-tubes he distinguishes three kinds, viz. (1) With coagulable sap; the contents consist of a slight parietal layer of protoplasm, and a clear sap which coagulates on heating (*Cucurbitaceæ*). (2) With mucilage; the contents consist of a delicate parietal layer of protoplasm with a larger or smaller admixture of mucilage, and a clear watery not coagulable sap (*Humulus*). (3) With starch-grains; the contents consist of a delicate parietal layer of protoplasm containing a small quantity of mucilage, and a clear not coagulable sap with starch-grains (*Coleus*). Most Dicotyledons belong to the third type; the rest, with the exception of *Cucurbitaceæ*, to

* Comptes Rendus, cv. (1887) pp. 359-60.

† SB. Bot. Verein Lund, March 17, 1887. See Bot. Centralbl., xxxi. (1887) p. 258.

‡ Annal. Ist. Bot. Roma, 4 pp. See Bull. Soc. Bot. France, xxxiv. (1887), Rev. Bibl., p. 51.

§ Ber. K. Sächs. Gesell. Wiss., 1886, 48 pp. and 2 pls. See Bot. Centralbl., xxxi. (1887) p. 8. Cf. this Journal, 1886, p. 268.

the second. In all, the sieve-plates are covered by a very thin layer of callus, which is either completely covered with mucilage, or only at the margins of the sieve-pores on both sides of the plate.

In the development of all three types, drops of mucilage are first formed in the parietal protoplasm. In the Cucurbitaceæ these are soon again absorbed; in other cases they remain; in the third type the starch-grains are formed at the same time. The author agrees with Russow that the callus is separated from the contents of the sieve-tube and not from the cellulose-plate. In Cucurbitaceæ the sieve-plate is slightly pitted before the formation of the callus, but the pitting is in all cases a secondary process after the tubes have emerged from the condition of cambium-cells.

The obliteration or cessation of the functions of the sieve-tubes, commences with changes in both the contents and the sieve-plates, which vary in different plants. They finally become completely empty; when they contain starch-grains, these are the last to disappear. The pores also become completely closed.

Dr. Fischer affirms that the sieve-tubes are in connection with one another and with the conducting cells, but not with the cambiform.

Effect of Stimulation on Turgescient Vegetable Tissues.*—Miss A. Bateson and Prof. F. Darwin have tried a series of experiments on the effects of water and other reagents on the increase in length of the turgescient pith of a growing shoot when freed from its surrounding tissues. The plants experimented on were *Helianthus tuberosus* and *H. annuus*. The increase in length was measured by means of an auxanometer-lever. One end of the pith was attached to the bottom of a narrow glass jar, the upper end being connected, by means of a thread of plaited silk, with the short arm of the lever. The following is a summary of the chief results.

Turgescient pith placed in water increases in length, at first slowly, then more quickly; and then again the rate of increase becomes more slow. The rate of increase in length increases as the temperature of the water rises, reaches an optimum, and suddenly falls as a temperature sufficient to cause flaccidity is approached. The following reagents cause distinct acceleration:—Alcohol, ether, ammonia, hydrocyanic acid. The first three produce a very temporary effect, whereas prussic acid has a prolonged action. The following reagents produce retardation:—Acetic acid, hydrochloric acid, and probably nitric acid. Dilute solutions of quinine chloride and of carbolic acid produce a remarkably rapid shortening of the pith.

Formation of Tyloses in the interior of Secretory Canals.†—Mdlle. A. Leblois states that she has lately made a series of researches on the origin and development of secretory canals. In the course of the investigation which was made on the branches of *Brucea ferruginea*, cells projecting into the interior of the secretory canals were observed. These cells were sometimes in the form of a hair or papilla, but more often they were club-shaped, and were formed by the projection of the cells at the border of the canal. Afterwards these cells were observed to divide by transverse septa. In the older branches, on account of their number, these cells somewhat filled up the canal; they then took on the appearance of tyloses.

The author concludes by stating that two types of tylosis might be distinguished: firstly, those that occur in the old vessels and which were described in 1845, and, secondly, those shown to occur in old secretory canals.

* Journ. Linn. Soc. Lond.—Bot., xxiv. (1887) pp. 1-27 (5 figs.).

† Bull. Soc. Bot. France, xxxiv. (1887) pp. 185-6.

Super-endodermal Network in the Root of Rosaceæ.*—M. P. van Tieghem has already described the structure of the cortical layer of the young root in Coniferæ and Cruciferæ in contact with the endoderm, which is furnished with a network of lignified thickenings. In this paper he continues this work with the Rosaceæ.

In a young root of the pear, each cell of the super-endodermal layer has a lignified thickening-band in the middle of the radial and transverse walls. This band projects towards the interior in a semicylindrical form, and incloses a rectangular cell. From each side of the common partitions the two bands correspond exactly, and unite to form one thick cylindrical band. The longitudinal and transverse bands constitute a network with rectangular meshes, and this forms a strong support for the young root.

Of forty genera of Rosaceæ examined by the author, thirty possess a super-endodermal network, and ten are destitute of one. These ten genera are confined to the three tribes Potentilleæ, Poterieæ, and Quillajeæ; but the first two also contain genera which possess a network. Among the Poterieæ, for instance, the Sanguisorbeæ have a network, while the Pimprenelleæ (*sic*) are destitute of one. Among the thirty genera of Rosaceæ which possess a network, various slight modifications are to be found; these the author describes in detail.

In conclusion, it will be seen that there are now three great families of plants in which the young root is provided with a super-endodermal network—the Coniferæ, Rosaceæ, and Cruciferæ. In the latter case only the meshes of the network are reticulated.

Anatomical structure of the wood of Leguminosæ.†—Herr A. Saupe finds that the separation of the order Leguminosæ into the three suborders Papilionaceæ, Cæsalpinieæ, and Mimoseæ, does not correspond to any general differences in the structure of the wood. All the species of particular tribes do, on the other hand, present common characters in this respect, as, for example, in the tangential section of the medullary rays. This is especially the case in the tribes Genistææ, Dalbergiææ, and Galegææ. Certain nearly related genera exhibit also a more exact resemblance in their microscopical characters, as, for example, *Gymnocladus* and *Gleditschia* among Cæsalpinieæ, and *Colutea*, *Halimodendron*, and *Caragana* among Papilionaceæ, and especially *Wistaria* and *Robinia*, which is the more remarkable from the difference in habit of these genera. Only rarely could the histological character of the wood be used in the discrimination of species, but this occurs in the genera *Cassia*, *Cercis*, *Podalyria*, and *Sophora*. The climbing *Acacia sarmentosa* agrees altogether in the structure of its medullary rays with the rest of the genus.

(5) Structure of Organs.

Formation of Roots in Austral Coniferæ.‡—Prof. S. Berggren describes a structure of the roots peculiar to certain Coniferæ from the southern hemisphere. In *Podocarpus* there are formed, along all the younger branches of the roots, two or three moniliform rows of globular or elliptical secondary roots, of constant length in each species, varying in different species from 0·25 to 2 mm. They consist, for the larger part, of spongy cortical tissue, the cell-walls of which have spiral or reticulate thickenings, which prevent their shrivelling up when dry. The function of these peculiar bodies appears to be the same as that of the aerial roots of

* Bull. Soc. Bot. France, xxxiv. (1887) pp. 221-3.

† Flora, lxx. (1887) pp. 259-68, 275-82, 295-316, 323-35.

‡ SB. Bot. Verein Lund, March 17, 1887. See Bot. Centralbl., xxxi. (1887) p. 257.

Orchidæ, to serve as a storehouse for water. These structures attain their largest development in *Araucaria*, where their branching gives them a coral-like appearance. In the Cupressinæ of the southern hemisphere they are altogether wanting. Northern representatives of those genera which are most abundant south of the equator, display this structure to a modified extent only.

Swellings on the Roots of Papilionaceæ.*—Herr A. Wigand gives a *résumé* of the extensive literature on this subject, and sums up in favour of Brunchorst's view, that the so-called "bacteroids" are true bacteria.

Root-tubers of Leguminosæ.†—Herr A. Tschirch describes a peculiarity in the structure of the digitate tubers in the root of *Vicia sepium*, in which there is no suberous sheath to prevent the passage of the food-material into the surrounding empty tissue. The same result is attained by the separation of a layer of parenchymatous cells, which divide by tangential walls into tabular cells, and the walls of these cells become strongly suberized.

Structure of Chenopodiaceæ.‡—From the examination of the comparative anatomy of the stem and root of a large number of species of Chenopodiaceæ, belonging to many different genera, Prof. St. Gheorghieff comes to the following general conclusions:—

The abnormalities in the stem and root are more frequent in the latter than in the former, being often found in the root and not in the stem, but never in the stem when they are not also in the root. They are especially characteristic of perennial, and more particularly of climbing species, or of the perennial parts, sometimes not making their appearance till the third or even the fourth year. It is only rarely that neither stem nor root displays abnormalities in its structure. The main point of the exceptional structure is the large number of concentric secondary zones of increase in thickness, and the separation of the phloem into separate bundles distributed over the whole of the transverse section of the stem and the root.

There are some species in which the peculiarities of structure are so specialized that they can be distinguished from one another by the stem or root only. This is the case with *Haloxylon Ammodendron*, *Halostachys caspia*, *Grayia Sutherlandi*, *Suaeda fruticosa*, and *Kochia prostrata*.

A general review of the structure of the natural order is given, with especial reference to the genera *Bosea*, *Kochia*, *Suaeda*, *Halostachys*, *Eurotia*, *Haloxylon*, *Hablitzia*, *Boussingaultia*, *Basella*, and *Grayia*.

Biaxial Shoots of Carex.§—While the mode of growth of the majority of species of *Carex* is a uniaxial sympodium, Herr A. Callmé points out that in two species, *C. digitata* and *ornithopoda*, the primary shoot remains sterile, producing leaves only, while in its axis arise leafless and fertile lateral shoots of the second order.

Development of the Suckers of Thesium humifusum.||—M. Leclerc du Sablon states that the structure of the suckers of *Thesium humifusum* has been studied with care by MM. Chatin and Solms-Laubach. Their development has, however, not been followed. In the neighbourhood of the growing point of the root a slight swelling can sometimes be noticed, analogous

* Wigand's Bot. Hefte, ii. (1887) pp. 88-97 (1 pl.). Cf. this Journal, *ante*, p. 429.

† S.B. Gesell. Naturf. Freunde Berlin, April 19, 1887. See Bot. Centralbl., xxxi. (1887) p. 224. Cf. this Journal, *ante*, p. 429.

‡ Bot. Centralbl., xxx. (1887) pp. 117-21, 150-4, 183-7, 216-9, 245-9, 280-3, 328-30, 359-65, 369-80; xxxi. (1887) pp. 23-7, 53-7, 113-6, 151-4, 181-5, 214-8, 251-6 (4 pls.). § Ber. Deutsch. Bot. Gesell., v. (1887) pp. 203-5.

|| Bull. Soc. Bot. France, xxxiv. (1887) p. 217-21.

to that of a very young root. If a transverse section be made in the middle of the swelling, it will be seen that the tissues of the root are modified. Some cells of the pericycle elongate radially, and divide by radial and tangential septa; the cells composing the endoderm and internal portion of the cortex also elongate and divide. In the middle portion of the cortex a separation is also produced. Thus it will be seen that, as in the case of *Melampyrum*,* the pericycle, endoderm, and cortex take part at the same time in the new formation. From this point the growth of the sucker is rapid. The author concludes by stating that the development of a sucker differs from that of a root, and its structure only accords with that of a root in a few characters.

Colour of Coloured Leaves.†—Prof. T. W. Engelmann has investigated the cause of the colouring of the leaves in a large number of plants in which they are normally coloured, and its relationship to the decomposition of carbon dioxide in the light.

The colouring may depend on two different causes: on a variation in the colour of the assimilating chromophyll-bodies, or on the occurrence in the leaf of special pigments in addition to the normal chromoplasts. In the first case, the colouring appears to be invariably light, and either pure yellow or yellow-green, with easy transition to ordinary chlorophyll-green; in the second case it is usually red-brown, dark purple-brown, purple-red, or violet. In the first group of cases there appears to be frequently a definite quantitative relationship between the amount of colouring matter and that of chlorophyll. The colouring matter of the leaves of the yellow variety of *Sambucus nigra* was especially investigated and described. The yellow tint does not appear to be due here to a pure xanthophyll, but to a mixture containing a small quantity of true chlorophyll and of chlorophyllan. In more refrangible light (about $\lambda = 0.53 \mu$), the yellow cells decompose relatively, if not absolutely, more carbon dioxide than the green, while in red and green light the green cells decompose, both absolutely and relatively, more than the yellow.

In the second group the seat of the pigment is usually the cell-sap; less often the cell-wall. In the latter case the colouring is mostly confined to small portions of the surface, causing variegated leaves. Of leaves coloured by a soluble pigment, about fifty kinds were examined. These may be divided into two groups, connected with one another by intermediate forms: those in which the leaves are normally coloured during the whole or the greater part of their existence, and those which are coloured only when young. The colouring is, in both these cases, usually, but not always, spread over the whole surface of the leaf.

With regard to the distribution of the pigment in the component tissues of the leaf, all the cells of the epidermis and its appendages, as well as the assimilating parenchyma, may contain coloured sap. In other cases only some of the epidermal cells of definite position are coloured. A red pigment is commonly contained exclusively in the assimilating tissue, especially in the palisade cells. That cells containing a purple sap can decompose carbon dioxide as energetically as those which contain pure chlorophyll is shown, among other examples, by the great size attained by the copper-beech, and the vigour of growth of the various species of *Coleus*. Neither the size, form, arrangement, colour, nor number of the chlorophyll-grains presents any peculiarity in such leaves. Only those rays appear to be absorbed by

* Cf. this Journal, *ante*, p. 778.

† Bot. Ztg., xlv. (1887) pp. 393-8, 409-19, 425-36, 441-50, 457-70 (2 pls.), and Arch. Néerland. Sci. Exact. et Nat., xxii. (1887) pp. 1-57 (2 pls.).

the pigment which are of the least importance in assimilation. A number of tables of wave-lengths and curves complete the paper.

Yellow Spots on Leaves.*—Dr. P. Sorauer has investigated the cause of the yellow spots on the leaves of a number of plants, and finds it due in all cases to a stretching of the cells of the mesophyll. The cells are at first empty, but become afterwards filled with a brown substance resulting from the breaking up and disintegration of the chlorophyll-grains in adjacent cells.

Bud-scales.†—Herr R. Cadura classifies the coverings of the buds of exogenous trees under four types, viz. (1) Collenchymatous coverings, consisting of elongated collenchymatously thickened parenchyma; (2) Parenchymatous coverings; (3) Periderm-like coverings, with parenchymatous cone and suberized apex; (4) Stereid-like coverings, with specific mechanical tissue. In the seventeen species examined, he finds one or other of these modes present, according to the need of the species for protection against excessive evaporation, radiation, cold, &c.

The casting-off of the bud-scale is brought about by the formation of a zone of tissue at their base, the *phelloid*, the cells of which contain large quantities of starch and granular protoplasm, and in which intercalary growth takes place owing to the traction exercised by the swelling bud.

Gentians.‡—Prof. T. H. Huxley gives the results of a survey of the natural order Gentianaceæ. Confining himself almost entirely to the study of the structure of the flower, he was able to distinguish some seven or eight modifications; and these were found to fall into two series, characterized by a peculiar disposition of the mechanical organs. The corolla presents a gradation of forms from the rotate, or rather stellate, condition, through the campanulate, to the extreme infundibuliform character. In one of these series the nectarial cells are situated on the inner surface of the cup, from the edge of which the lobes of the corolla proceed, and towards its basal end. The Gentianaceæ of this series the author terms *Perimelitæ*. In the other series there are no such patches of secreting cells visible on the corolla; but in many members of the series there is a zone of such cells, encircling the base of the ovary. These are termed *Mesomelitæ*.

In the series of the *Perimelitæ* four modifications of floral structure are discernible, and about the same number in the *Mesomelitæ*. The author gives names to each of these groups, and traces their relationship one to another, and also the geographical distribution of each.

Inflorescence of Typha.§—From a comparison of the structure of the inflorescence in the few species of *Typha*, Dr. M. Kronfeld supports Celakovsky's view that it is essentially of the same type of structure as that of *Sparganium*, and that the distinct zones of flowers are in reality axillary shoots. Even the female partial inflorescence is composed of several, or at least of two, internodes.

Axis of the Inflorescence.||—Dr. E. Dennert discusses in great detail the variations in the anatomical structure of this organ, to adapt it to different conditions. At the time of flowering the passage from the leafy

* Forsch. a. d. Geb. d. Agriculturphysik, ix. pp. 387-96. See Bot. Centralbl., xxxi. (1887) p. 279.

† Cadura, R., 'Physiol. Anat. d. Knospen-decken dikotyler Laubbäume,' 42 pp., Breslau, 1887. See Bot. Centralbl., xxxi. (1887) p. 87.

‡ Journ. Linn. Soc. Lond.—Bot., xxiv. (1887) pp. 101-24 (1 pl.).

§ SB. K. Akad. Wiss. Wien, xciv. (1887) pp. 78-108 (1 pl. and 2 figs.). Cf. this Journal, ante, p. 114.

|| Wigand's Bot. Hefte, ii. (1887) pp. 128-217 (1 pl.).

stem to the immediate flower-stalk is marked by a decreased development of tissue, a rapid diminution in the number of bundles, and reduction of the pith. When the fruit is ripe the difference consists only in a diminished number of bundles and reduction of the pith, together with the absence of secondary vessels. Up to the period of ripening, the mechanical elements within the inflorescence are becoming gradually strengthened, which may take place either in the woody parenchyma or in the hard bast. In other cases, an extra-cambial sclerenchymatous ring or other form of sclerenchyma, makes its appearance, or a secondary sclerosis takes the place in the pith. The conducting tissue is also strengthened, and in some cases the cortical tissue. Not unfrequently the fruit-stalk is thickened immediately beneath the fruit.

Comparative Anatomy of Flower- and Fruit-stalks.*—Herr F. Besser classifies under four heads a large number of flower- and fruit-stalks examined by him, viz. (1) The flower-stalk has no mechanical tissue and the fruit-stalk only bast (*Linum usitatissimum*, *Prunus Cerasus*, *Platycodon grandiflorus*, Monocotyledons); (2) The flower-stalk has collenchyma, the fruit-stalk also bast (*Cucurbita Pepo*, *Citrullus vulgaris*, Papaveraceæ); (3) The flower-stalk has collenchyma, the fruit-stalk also libriform (*Campanula lactiflora*, *Scabiosa*, *Asterocephalus brachiatus*); (4) The flower-stalk has collenchyma, the fruit-stalk also libriform and a much smaller quantity of bast (*Malvaceæ*, *Solanaceæ*). *Asparagus officinalis* stands alone with its strongly developed sclerenchymatous tissue.

Bast-cells with vertical transverse walls are common; libriform fibres also occur. Notwithstanding the temporary duration of these organs, it is not uncommon to find a more or less complicated assimilating system.

Blossom on Old Wood.†—Dr. P. Esser remarks that many plants, especially tropical ones, produce flowers on parts of the wood which are several years old. After enumerating examples, he refers to Wallace's suggestion that flowers so produced near the stem, and under the shadow of the leaves, are for fertilization by the shadow-loving butterflies of tropical forests, and also to Johow's belief that by flower-bearing on old and hard parts, a plant is enabled to bear the weight of much larger and heavier fruits than it could otherwise support. He then gives the details of his own experiments on *Cercis*, *Goethea strictiflora*, *Theophrasta*, *Ficus Roxburghii*, and *Chrysophyllum Cainito*. He treats, in each case, of the anatomy of the wood; of the formation of a larger number of buds than is common; of the way in which these buds develop further; and of the manner in which their connection with the vessels of the stem is ultimately recovered.

The conclusions from these observations he sums up as follows:—

(1) There is no such thing as the production of adventitious buds upon wood whose development is once completed; but flowers appearing on old wood come rather, as Johow correctly indicated, from early formed buds which have been resting:

(2) With regard to the formation of these buds, which are all placed in the axils of leaf-shoots, we must distinguish between the following cases:—

(a) In each leaf-axil several buds are formed in series, most of which produce inflorescences after shorter or longer periods of rest. (*Chrysophyllum*.)

* Besser, F., 'Beitr. z. Entwicklungsgesch. u. Vergleich. Anat. v. Blüten- u. Frucht-stielen,' 32 pp., Lössnitz, 1886. See Bot. Centralbl., xxxi. (1887) p. 93.

† Verh. Naturh. Ver. Bonn, xlv. (1887) pp. 69–112 (1 pl.).

(b) In each leaf-axil a bud is placed, which in turn produces other buds in the axils of some of its lower leaves. These, often simultaneously with their mother-bud, are applied to flower-bearing after rest during several years. (*Ficus Roxburghii*.)

(c) In each leaf-axil two or more buds are placed in a row, which, on their part, form other buds in the axils of their leaves, the lower ones placed on the production of the leading shoot, and these buds appear one after another. (*Theophrasta, Goethea*.)

(d) In each leaf-axil a meristem is formed, from which, very slowly, it would appear that many buds are produced in rows, which develop after several years of rest.

(3) In some cases, not only single inflorescences are produced, but flowering shoots, that continue to blossom for many years.

Stipules and Petals.*—Observation of the stipules and flowers of the rarely flowering *Magnolia Frazeri* has confirmed Mr. T. Meehan in the conclusion previously arrived at by him that the petals of most flowers should be considered enlarged stipules, or thinly dilated bases of petioles, rather than modified leaves. This is especially the case with many kinds of rose. In the *Magnolia* the transition from stipules to petals is very well seen.

Amyloid Corpuseles in Pollen-grains.†—Investigating the starch-like structures found in the fovilla of pollen-grains, called by Saccardo "somatia," in upwards of two hundred plants, Sig. C. Zatti finds that some of them are coloured blue, others a light yellow by iodine-reagents. To the former, which vary greatly in size and form in different species, he applies the term *eusomatic*; to the latter, which are minute and globular, *notosomatic*. This difference does not correspond closely to any natural system of classification. Thus, among the Ranunculaceæ, the Clematideæ, Anemoneæ, and Pæoniæ are notosomatic, while the Ranunculeæ are eusomatic. All the species of Malvaceæ and Rosaceæ are eusomatic; while, on the other hand, all the Papaveraceæ, Crucifereæ, and Caryophyllaceæ are notosomatic.

Forms of Seedlings and the causes to which they are due.‡—In the second part of his paper on this subject, Sir John Lubbock continues his phytobiological observations as to the influence of the leaf on the cotyledon. He describes in detail the seedlings of various Onagrarieæ, some of which have very curious cotyledons. For instance, in *Oenothera Bistorta*, the cotyledons are long and linear, but suddenly widen at the end into a large orbicular expansion, which gives them a very peculiar appearance. In the case of unequal cotyledons, the instance of *Coreopsis Atkinsoniana* is well worth a little attention. The seeds are obovate, curved longitudinally, and compressed dorsiventrally, conforming to the interior of the fruit. The embryo is slightly bent, following the direction of the seed. Consequently the one cotyledon occupies the inner, the other the outer side of the curve; and the outer one is distinctly larger than the other. As to the position of the embryo in the seed, the genus *Plantago* is noticed, the position varying with the different species. Divided cotyledons are far from frequent; an instance occurs in the lime (*Tilia vulgaris*). The author concludes with some remarks on the form of the leaf in the tulip-tree, *Liriodendron*, which he regards as being determined by the exigencies of the folding up of the lamina and the stipules within the leaf-bud.

* Proc. Acad. Nat. Sci. Philadelphia, 1887, pp. 155-6.

† Bull. Soc. Ven.-Trent. Sci. Nat., iv. (1887) pp. 40-1.

‡ Journ. Linn. Soc. Lond.—Bot., xxiv. (1887) pp. 62-87 (42 figs.). Cf. this Journal, ante, p. 112.

B. Physiology.*

(1) Reproduction and Germination.

Pollination of *Pleurothallis ornatus*.†—Mr. F. W. Oliver describes the peculiarities of the structure of the flower of this orchid. Each sepal is fringed with a row of cilia rendered vibratile by their very narrow base, and conspicuous from containing nothing but air. Their swaying backwards and forwards with every breath of wind renders them much more conspicuous to visiting insects. The labellum is small, and moves narrowly on its narrow neck when touched. Being quite hidden, this motion cannot be for the purpose of rendering the flower more conspicuous, as in the case of some other orchids, but appears to insure the insect's head being thrust against the stigma or pollinia.

(2) Nutrition and Growth.

Conditions of Assimilation.‡—Dr. N. Pringsheim communicates a preliminary account of his researches on the dependence of assimilation in green cells on the liberation of oxygen, and on the locality within the cell where the oxygen formed in assimilation actually originates. He notes the limitations of the prevalent method of gas analysis, and has striven by direct observation of the protoplasm to determine the seat and relations of the various functions. It seemed likely that the observation of protoplasmic movements in varying conditions of light and darkness, and in partial or total removal of oxygen, would afford a suitable starting-point for his researches. Previous experiments had forcibly suggested that observed differences in the assimilative energy did not in any way depend on differences in the number of chlorophyll-bodies, nor on the abundance of chlorophyll within these, but on the oxygen respiration of the protoplasm. This point Pringsheim sought further to investigate.

It has been known for long the green cells can break up carbonic dioxide in the absence of oxygen, where the carbonic dioxide is mixed with some innocuous gas. It is also known that protoplasmic movement is dependent on the presence of oxygen. If this be so, the protoplasmic movement in a green assimilating cell, in a medium free from oxygen, should not come to a standstill as long as it is illuminated, and the conditions of carbonic acid analysis fulfilled. With these facts in view, Pringsheim tried by experiment to answer the question whether a plant normally assimilating would cease to assimilate, without any alteration of the chlorophyll relations, if it were deprived, even for a short time, of the oxygen which is essential for respiration and plasmic movement, and whether it would recommence to assimilate whenever fresh oxygen was supplied. His experiments answered this in the affirmative.

The naked terminal cells of *Chara* leaves were placed in suspended drops in a microscopic gas-chamber; oxygen was as far as possible excluded; a continuous stream of carbonic acid and hydrogen passed through; and the amount of light caused to vary. In darkness the rotation of the protoplasm gradually ceases, the length of time before stoppage varying with the degree to which oxygen is successfully excluded, with the specific nature of the cell, and with the mass of the protoplasm. The final result is a state of complete "asphyxia," when the cell is dead, though still normal morphologically.

* This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth; (3) Movement; and (4) Chemical Changes (including Respiration and Fermentation).

† Nature, xxxvi. (1887) pp. 303-4 (4 figs.).

‡ SB. Preuss. Akad. Wiss. Berlin, 1887, pp. 763-77, and Ber. Deutsch. Bot. Gesell. v. (1887) pp. 294-307.

If the cells be taken just before asphyxia, just when the protoplasm is ceasing to move at all, it will be found that they are no longer able to assimilate. They are still quite normal, but if now placed in an illuminated chamber, and supplied as before with carbonic acid, the rotation will not return. A little free oxygen restores the original state, but without this, in spite of the presence of light, chlorophyll, and carbonic dioxide, no oxygen is formed. This state Pringsheim calls "inanition" or "Ernährungs-ohnmacht." What has been noted in regard to its occurrence goes to show the dependence of assimilation on the absorption of oxygen.

But it is also a fact that the same phenomena of inanition occur when cells in similar circumstances are kept continuously in the light. Repeating the above experiment with continuous illumination instead of darkness, Pringsheim again observed the stoppage of rotation, and with it the cessation of the liberation of oxygen. The absence of free oxygen is again the condition of cessation of function; if a small quantity be introduced the life revives, if at least the inanition has not gone too far.

How is this to be explained in terms of the generally accepted theory of assimilation? *If the disruption of carbonic dioxide within the cell furnishes oxygen directly*, how should any assimilating cell suffer from want of oxygen? Pringsheim does not admit the usual assumption italicized above. His opinion is that the analysis of the carbonic dioxide in assimilation does *not* directly furnish oxygen, but that some other substance is formed, which, passing diosmotically to the surface, breaks up and liberates free oxygen. He criticizes the usual arguments based on the results of gas analysis. What the substance is which forms oxygen at the surface he is not yet prepared to state.

If this be so, the breaking up of carbonic dioxide and the liberation of oxygen are two processes, distinct both in space and time, the one occurring within the cell, the other at its surface. This view is supported by reference to the peculiar liberation of oxygen exhibited in darkness by both green and unpigmented cells towards death. The bacterium-method proves this fact incontestably. This liberation of oxygen in darkness, and quite independent of contemporaneous assimilation, may be termed "intramolecular liberation of oxygen," and, according to Pringsheim, the normal liberation is an essentially similar process, resulting from the disruption of an exosmosing substance.

He advances other arguments to show that we are not warranted in concluding, as has been hitherto done, that the presence of chlorophyll, light, and carbonic dioxide exhaust the conditions of assimilation, and that in estimating its amount no other factors but light-energy and the absorption of light by the chlorophyll have to be taken into account. Assimilation is, on the contrary, a physiological function of the protoplasm, and, like the movement, depends on the presence of free oxygen. Physiologists will look with interest for Pringsheim's detailed account of his investigations on this important subject.

Influence of Stretching on the growth of Plants.*—Dr. M. Scholtz has experimented on the influence on the growth in length of various plants—*Helianthus annuus*, *Tropæolum majus*, *Fagopyrum esculentum*, *Linum usitatissimum*, *Ipomæa purpurea*, *Sinapis alba*, *Cucumis sativus*—of weighting the growing stems with small weights, varying from 5 to 150 grammes. The possibility of heliotropic curvatures was carefully excluded.

He finds that the weight exercises on the growing stems two opposite influences, the one accelerating, the other retarding the growth. Both take

* Cohn's Beitr. z. Biol. der Pflanzen, v. (1887) pp. 323-64.

place at the same time, and their relative intensity determines whether the growth of the plant is accelerated, retarded, or remains the same. With more sensitive plants (*Ipomæa purpurea*, *Linum usitatissimum*, *Tropæolum majus*) the retardation is the stronger force; in those which are less sensitive (*Helianthus annuus*, *Cucumis sativus*, *Fagopyrum esculentum*) the retardation is perceptible to measurement only during the first days, when the weight is not nearly sufficient to rupture the tissues. With greater weight it cannot be measured even on the first day, although no doubt present. But while with more sensitive plants the retardation is permanent, with the less sensitive it disappears altogether, and after the first day a distinct acceleration is perceptible. Differences are also dependent on the amount of weight and the age of the plant. The growth of the plant in thickness is not reduced.

Reproduction of parts of Plants.*—Prof. F. W. C. Areschoug explains the tendency of some parts of plants to produce leaf-buds, and others roots, or of the same part to produce buds or roots under different conditions, by the hypothesis that buds are produced by those parts where there is a larger, roots by those parts where there is a smaller, accumulation of nutrient material; stems requiring a larger amount of nutriment than roots, in consequence of their larger size and greater complexity of structure. Thus in all trees the strongest shoots spring, not from the lower, but from the upper part of the previous year's shoot, where there is a larger supply of nutriment. Again, leaves, in which the supply of food-material is limited, as a rule produce roots only, but occasionally shoots from their basal portion.

(4) Chemical Changes (including Fermentation).

Formation of Albumen in Plants.†—According to Herr A. Emmerling, the total amount of nitrogen increases during the first period of growth of plants, especially in the leaves, until the commencement of the formation of the seeds. From this time it remains nearly constant in the leaves, but increases very rapidly in the fruits. The same is the case with the albuminoids. The non-albuminous nitrogen decreases, as a rule, as the amount of albuminoids increases, especially in the seeds and seed-vessels; while in the leaves it retains nearly the same proportion until the seeds are ripe, but increases again, during the last stage, owing to retrogressive metastasis.

Of the non-albuminous nitrogenous constituents, the amido-acids occur in especial abundance in the leaf-buds, floral organs, young seeds, and seed-vessels. In the leaves the amount of these acids remains constant for a long period, decreasing afterwards considerably; and this is the case also in the roots, seeds, and seed-vessels. From this it is seen that the amido-acids formed in plants are gradually transformed into other nitrogenous substances, and especially into albuminoids; and that the capacity of the plant to produce these acids decreases with age.

The course of the formation of nitrogenous substances in *Vicia Faba* appears to favour the hypothesis that the amido-acids are formed synthetically in the plant, especially in the leaves, and that they are conveyed to the plants where fresh formation of cells is taking place, such as the growing-points and the seeds, where they are then transformed into albuminoids. Since therefore it must be supposed that every young cell

* Bot. Centralbl., xxxi. (1887) pp. 186-8, 220-3.

† Landwirthsch. Versuchs-Stat., xxxiv. (1887) pp. 1-91. See Naturforscher, xx. (1887) p. 267.

constructs the albuminoids of its protoplasm out of amido-compounds, the formation of amido-acids is a very important item in the processes of metastasis.

Theory of Fermentation.*—Herr N. W. Diakonow has published the first part of a detailed account of his investigations on "the rôle of the fermentable nutritive substance in the life of the vegetable cells." His results will be summarized when his memoir is completely published.

He gives a clear historical introduction, resuming the progress of investigation in regard to fermentation from the researches of Thénard onwards. The various theories are briefly stated and compared.

The point on which his own researches were first concentrated was that of the influence of the composition of the nutritive substances transformed by the fungus on the nature of the gaseous transformations effected in the surrounding medium. The nature of the gaseous exchange with the external medium, as determined by the fungus, varies according to the chemical composition of the nutritive substances taken in, and differs of course markedly from what takes place in a simple combustion of the same substances. The relation between the quantity of oxygen absorbed and carbonic acid gas given off is determined by the proportion of oxygen in the nutritive substance. The author has sought to determine what relation obtains between the intensity of the liberation of carbonic acid in the absence of atmospheric oxygen and the quantity of oxygen in the nutritive material. The nutritive substances used were glucose, lactose, chinic acid, and tartaric acid. The fungi experimented on were *Penicillium glaucum*, *Aspergillus niger*, and *Mucor stolonifer*. A detailed description is given of the methods of research.

Alcoholic Fermentation.†—Prof. F. Delpino contests the modern view that the process of the fermentation of grape-sugar is a complicated one, in which succinic acid and glycerin are produced. These substances he believes not to be the direct products of fermentation, but, when found in the fermented liquid, to be degraded substances resulting from processes connected with the plastic or proteinaceous nutrition of the saccharomycete. He reverts to the older view that the effect of the ferment is to decompose the sugar directly into alcohol and carbon dioxide.

Prof. Delpino proposes to unite the forms known as *Saccharomyces cerevisiæ*, *minor*, and *ellipsoideus*, into a single species with the name *S. zymogenus*.

Chemical nature of Diastase.‡—Dr. C. J. Lintner contests Hirschfeld's statement that vegetable diastase is a special molecular modification of a particular germ. He asserts, on the contrary, that it contains nitrogen, and presents many points of similarity to the albuminoids, although it cannot be included under this group of substances. A more exact composition he is not able to give.

γ. General.

Adaptation of Plants to rain and dew.§—Prof. N. Wille records the results of a series of experiments for the purpose of determining the extent to which plants can absorb moisture through their aerial organs. The experiments were made on a number of species, by placing on them

* Arch. Slav. Biol., iv. (1887) pp. 31-61. Cf. this Journal, *ante*, p. 619.

† Nuov. Giorn. Bot. Ital., xix. (1887) pp. 260-2.

‡ Pflüger's Arch. f. Ges. Physiol., 1887, pp. 311-4.

§ Cohn's Beitr. z. Biol. d. Pflanzen, iv. (1887) pp. 285-321. Cf. this Journal, *ante*, p. 119.

drops of a 1 per cent. solution of lithium chlorate, and then determining, by means of the spectroscope, the extent to which the lithium was absorbed. The general results obtained were that water is absorbed so slowly and in such small quantities through these organs in comparison to the root, that it is without physiological value to the plant. This applies both to the ordinary leaves and to those parts which are designated by Lundström as specially constructed organs for the absorption of water.

Bleeding.*—Herr C. Kraus has examined the phenomena of "bleeding" in a number of species, both woody and herbaceous. He finds it to be invariably the case that when the plant is still attached to the soil by its root, the sap that first exudes from the wound is acid, while that which flows out later is either neutral or slightly alkaline; and the same is the case with cut shoots of the vine. The exuding sap is derived partly from the vessels and tracheids of the wood, partly from the tissue immediately adjacent to the wound. A larger amount of bleeding takes place, as a rule, from younger than from older shoots.

Sachs's Vegetable Physiology.†—This most important work, an enlargement of a portion of Prof. J. von Sachs's 'Text-book of Botany,' is divided into six sections, viz.:—(1) Organography; (2) The External conditions of Vegetable life; (3) Nutrition; (4) Growth; (5) Irritability; (6) Reproduction. Under the head of Organography all the organs of a plant are classified under five heads, viz.:—(1) Root; (2) Shoot (including leaves); (3) Sporangia and Spores; (4) Archegonia; (5) Antheridia. In the section on Nutrition, a very large space is devoted to the phenomena connected with the absorption of water and the passage of nutritive material from one part of the plant to another; and the author adheres to his previous view that the transfer is effected through the lignified tissues.

B. CRYPTOGRAMIA.

Symbiosis of a Bacterium and Alga.‡—Dr. M. Kronfeld objects to Tomaschek's description of the association observed between a *Bacillus* and a *Glæocapsa* as "symbiosis,"§ on the ground that it is not shown that the latter can derive any possible benefit from the former. He considers it more probable that the so-called bacillus is really the product of the breaking up of the filaments of an alga, a similar phenomenon having already been described by Zukal in the case of *Drilosiphon*.||

Cryptogamia Vascularia.

Apospory.¶—Prof. F. O. Bower repeats in detail the phenomena connected with the aposporic reproduction already described by Drewry and himself in the ferns *Athyrium Filix-femina* var. *clarissimum*, and var. *plumosum elegans*, and in *Polystichum angulare* var. *pulcherrimum*. He points out that sporal arrest may occur, irrespective of the presence or absence of these substitutionary vegetable growths which so often accompany it. In the first and last varieties mentioned above the arrest in the development of the spores is, in the majority of cases, complete, not advancing

* Forsch. a. d. Geb. d. Agricultur-physik, x. (1887) pp. 67–144. See Bot. Centralbl., xxxi. (1887) p. 137.

† Sachs, J. v., 'Lectures on the Physiology of Plants,' translated by H. Marshall Ward, 836 pp. and 455 figs., Oxford, Clarendon Press, 1887.

‡ Bot. Centralbl., xxxi. (1887) pp. 350–2.

§ See this Journal, ante, p. 785.

|| Ibid., 1884, p. 601.

¶ Trans. Linn. Soc. Lond.—Bot., ii. (1887) pp. 301–26 (3 pls.). See this Journal, 1885, pp. 99, 491; ante, p. 622.

beyond the appearance of the archesporium. Substitutionary growths may take the form of (1) simple proliferation; (2) sporophoric budding; or (3) apospory. The second of these forms includes the well-known development of bulbils on the fronds of some ferns. Apospory includes all those cases in which the substitutionary growth following sporarrest results in the formation of organs having the characteristics of the oospore. This occurs naturally in the cases of the ferns above-mentioned, and may be induced artificially in mosses. In two of these there is a distinct transition from the sporophore to the oospore without the intervention of spores, and by a simple vegetative budding. In *A. Filix-fem.* var. *clarissimum*, the substitutionary growths which accompany the arrest of spore-formation are restricted to the sporangium itself; while in *P. angulare* var. *pulcherrimum*, the prothalloid growths may either proceed from the sorus, or may appear at quite distinct spots, and even on fronds which bear no sori at all, and comparable therefore in position to the common formation of sporophoric buds on the fronds of ferns.

The author concludes by comparing the aposporic phenomena in ferns to the cases of arrest which occur either exceptionally or nominally in mosses in *Chara* and in *Isoetes*, and to the phenomenon of parthenogenesis in flowering plants.

Structure of Mucilage-cells of *Blechnum occidentale* and *Osmunda regalis*.*—Messrs. W. Gardiner and Tokutaro Ito have examined the cells which secrete the slimy mucilage in *Blechnum occidentale*, wherein each hair of the terminal cell is glandular, and *Osmunda regalis*, where all the cells of the hair are usually secretory in function. They found that the mucilage arises from the protoplasm only, and not from the cell-wall, and that the whole process is distinctly intraprotoplasmic. The very words used by Langley in the description of certain animal secretory cells may be used of these ferns, for the cell-substance of the mature cells is composed of a framework of protoplasm connected at the periphery with a thin continuous layer of modified protoplasm (ectoplasm), while the meshes of the framework inclose two chemical substances at least, a hyaline substance in contact with the framework, and spherical granules imbedded in the hyaline substance. In other words, the mucilage is secreted in the form of drops, and each drop is further differentiated into a ground substance (gum mucilage), in which are imbedded numerous spherical droplets (gum).

Secretion commences by the breaking down of a portion of the innermost layers of the protoplasm at a number of contiguous but isolated areas; the result is the formation of small but rapidly growing mucilage drops. These last are at first watery and by no means well defined, but they soon become denser, and tannin is uniformly distributed throughout their structure. A delicate reticulation may now be observed in the drops, and this finally gives way to the appearance of numerous minute and brightly shining droplets, all separate and distinct.

Usually plant-cells are incapable of the active and repeated secretion which is seen in the animal secretory cells; and those of *Blechnum* and *Osmunda* die when they have formed their secretion; but in other cases, as e. g. the glands of *Dionæa*, it appears exceedingly probable that there are periods of rest and of repeated secretion, as in animals.

The secretion of the cells escapes by the rupturing of the cell-wall. In *Osmunda* the whole system is perforated by fine holes, which in the

* Ann. of Bot., i. (1887) pp. 27-54 (2 pls.), and Proc. Roy. Soc. Lond., xlii. (1887) pp. 353-5.

functional cell are filled by delicate strands of protoplasm; these establish a direct continuity between the protoplasmic contents of the various cells of the hair. The authors believe that, in their main features, the phenomena attending the formation of the secretion are very widespread, and limited neither to ferns nor to the particular case of secretion of mucilage.

Leaves of Ferns.*—Herr A. Vinge notices some peculiarities in the structure of the leaves of ferns, corresponding to the needs of the species as regards transpiration. In many thin-leaved ferns the mesophyll is almost entirely undifferentiated. Not unfrequently we find intercellular prolongations from the walls of the mesophyll-cells, especially in the neighbourhood of the stomata. The thick leaves of *Adiantum macrophyllum* have a very loose tissue; while, on the other hand, the mesophyll of *Polypodium ireoides* is very dense. The greatest differentiation of tissue was found in *Nipholobolus Lingua*. Beneath the upper epidermis, a hypoderm consisting of two layers, then a palisade-parenchyma of from one to three layers with the ordinary isodiametrical layers within, the whole structure closely resembling that of a dicotyledonous leaf.

Muscineæ.

Fructification of *Grimmia Hartmanni*.†—M. Philibert describes this moss as resembling in the sterile state *Rhacomitrium sudeticum*, from which, however, it is distinguished by the tissue of the leaves. The perichætal leaves are of the same shape as the cauline leaves, only their base is rather more sheathed, and the tissue in the lower part is composed of rectangular cells, which are looser and more transparent. Rarely two fruits come from the same perichætium. The pedicel is three or four millimetres in length and twisted into a spiral; when moist, it is bent in an arc, so that the capsule is at an angle of about 45° with the vertical. The capsule is oval-oblong, very smooth, and is pale in colour with a reddish margin. Its length without the operculum from 1.5 to 1.7 mm., the diameter from 0.75 mm. The operculum is conical, subulate, and slightly oblique. The teeth of the peristome are linear-lanceolate, obtuse, entire, and of an orange-red colour; the two lower rows are very smooth. In conclusion, the author states that *Grimmia Hartmanni* ought to be placed among the true *Grimmiæ* near to *G. contorta* Wahl.

Sphagnaceæ of North America.‡—In a revision of the Sphagnaceæ of North America, M. J. Cardot states that that continent possesses several subtropical types not found in Europe, while only one European form (*S. Angstreemii*) is at present absent from it.

Algæ.

Siphoneæ.§—The most recently published part of Prof. J. G. Agardh's Classification of Algæ refers to this group, in which he includes Dasycladaceæ and Valoniaceæ. The whole group is divided by him into six families as follows:—I. BRYOPSIDEE (*Bryopsis*, *Derbesia*?). II. SPONGODIEE (*Codium*?, *Cladothela*). III. UDOTACEE (*Chlorodesmis*, *Avrainvillea*?, *Espera*, *Penicillus*, *Rhipocephalus*, *Callipsygma* n. gen., *Udotea*, *Rhipidosiphon*?, *Halimeda*). IV. VALONIAE (*Valonia*, *Siphonocladus*, *Ascothamnion*?,

* Bot. Centralbl., xxxi. (1887) pp. 290-3. † Rev. Bryol., xiv. (1887) pp. 49-52.

‡ Bull. Soc. Bot. Belg., xxvi. (1887) pp. 44-61.

§ Agardh, J. G., 'Till Algernes Systematik,' in Lunds Univs. Arsskr., xxiii. (1887) 180 pp. and 5 pls. See Mrs. Merrifield, in Nature, xxxvi. (1887) p. 313.

Trichosolen?, *Apjohnia*, *Struvea*, *Chamædoris*, *Dictyosphæria*, *Anadyomene*). V. CAULERPEÆ (*Caulerpa*). VI. DASYCLADEÆ (*Dasycladus*, *Chlorocladus*, *Botryophora*, *Cymopolia*, *Neomeris*, *Bornetella*, *Halicoryne*, *Polyphysa*, *Acetabularia*, *Pleiophysa*?). Under *Avrainvillea* are included *Fradelia*, *Chloroplegma*, and *Rhipilia*. *Chlorodictyon* and *Codiolum* are altogether excluded.

The position of a number of these genera is provisional only, as in a considerable proportion of them the fructification and mode of reproduction are unknown, and for the same reason the delimitation of the families depends on characters which have no permanent value.

Growth of the Cell-wall and other phenomena in the Siphonæ.*—In order to determine the question whether the growth of the cell-wall takes place by apposition or by intussusception, Herr F. Noll suggests the use of staining reagents which shall colour the fully formed parts of the cell-wall, while the parts in process of formation are left uncoloured. For this purpose he employed Berlin blue or Turnbull's blue, and applied the test to marine algæ in which the cell-wall grows with great rapidity, viz. *Caulerpa prolifera*, and species of *Bryopsis* and *Derbesia*. Having coloured the cell-walls already formed in the way indicated, their growth was then continued without further staining, when new colourless lamellæ of the cell-wall were found to be formed within those coloured blue, showing that the growth takes place by apposition only. In the transparent tubes of *Bryopsis* and *Derbesia* it was clearly seen that no increase of thickness took place by intussusception, and the same was the case also with the apical growth.

Herr Noll also investigated the function of the remarkable bands of cellulose within the tube of *Caulerpa*, which have generally been supposed to be for the purpose of strengthening. He found that they could have no appreciable value for this purpose, but that they display an extraordinary power of conduction in the direction of their length. Their object appears to be to promote the rapid passage of oxygen and other substances to the interior of the elongated cell, where they are required for respiration and other purposes.

The seat of the phenomena of heliotropism and geotropism displayed by these algæ was determined to be the parietal layer of protoplasm. In these plants of low organization external forces have much more direct influence than in higher plants, where morphological differentiation of organs for special purposes has already taken place.

Fresh-water Chætomorphas.†—Herr G. Lagerheim describes a new species of *Chætomorpha* (*C. Herbipolensis*) from water in a conservatory at Würzburg, and discusses also all the species of this genus that are brackish or fresh-water in contrast with the larger number of marine species.

Sensitiveness of Spirogyra to shock.‡—Mr. S. Coulter records the observation that if filaments of *Spirogyra* are cut through as carefully as possible with the sharpest instrument, eight or ten cells nearest to the laceration showed striking changes in their protoplasmic contents, the spiral bands of chlorophyll being broken up and exhibiting a tendency for the protoplasm to collect round certain definite centres. It was a noteworthy fact that the pond from which the *Spirogyra* was taken contained water which was always at a comparatively high temperature; under ordinary conditions the same sensitiveness was not displayed by the *Spirogyra*.

* Bot. Ztg., xlv. (1887) pp. 473-82.

† Ber. Deutsch. Bot. Gesell., v. (1887) pp. 195-202 (1 pl.).

‡ Bot. Gazette, xii. (1887) pp. 153-7 (5 figs.).

Gynandrous Vaucheria.*—Under the name *Vaucheria orthocarpa* Herr P. F. Reinsch describes a new species, distinguished (in addition to other characters) by displaying gynandry. Besides the antheridium which springs laterally from the base of the oogonium, the latter organ produces a second antheridium at its apex, which develops precisely like a normal one. Only partial impregnation appears to take place in these cases, and the resulting oospore not to be capable of germination.

Fresh-water Algæ of New Zealand.†—Dr. O. Nordstedt describes the fresh-water algæ (except diatoms) brought from the hot-lake district of the Northern Island, New Zealand, and the Alps of the Southern Island—305 species and 55 varieties. They present but few novel features, and include 28 species of *Edogoniaceæ*, 8 of *Chætophoreæ*, 1 of *Chroolepidæ*, 17 of *Confervaceæ*, 1 of *Ulvaceæ*, 8 of *Pediacetræ*, 4 of *Protococcaceæ*, 9 of *Palmellaceæ*, 3 of *Volvocineæ*, 2 of *Vaucheriaceæ*, 5 of *Siphonææ*, 1 of *Mesocarpææ*, 7 of *Zygnemææ*, 152 of *Desmidiææ*, 5 of *Rivulariaceæ*, 7 of *Sirosiphonaceæ*, 7 of *Nostocææ*, 10 of *Oscillariææ*, 2 of *Chamæsisiphonaceæ*, 10 of *Chroococcaceæ*. The new species include 1 of *Aphanochaete*, 1 of *Rhizoclonium*, 1 of *Desmidium*, 1 of *Hyalotheca*, 1 of *Micrasterias*, 5 of *Euastrum*, 5 of *Staurostrum*, 4 of *Xanthidium*, 9 of *Cosmarium*, 2 of *Triploceras*, 1 of *Closterium*.

Pores in Diatom-valves.‡—Herr O. E. Imhof claims to have detected, in large species of *Surirella* and in one of *Campylodiscus* from the Cavloccio lake in Upper Engadin, very fine canals in the wings, which open out at the edges in minute elliptical openings, through which pass protoplasmic filaments united into a continuous thread. These he regards as the true motile organs of diatoms.

Lichenes.

Apothecia of Lachnea theleboloides.§—Sig. F. Morini describes the development of the apothecia of this lichen, which resembles that of *Ascobolus furfuraceus*. On the mycelium appears a short thick branch, rich in granular protoplasm, which shows spiral curves to the extent of $2\frac{1}{2}$ coils. At the free end of this branch is differentiated, by the formation of a septum, a terminal cell which soon assumes an ovate-spherical form. This is the mother-cell of the asci. The spirally coiled cell is segmented in the middle by a septum; the protoplasm passes out of the two cells thus formed into the terminal cell, and the basal cell dies away. At the base of the terminal cell now appears a conical thick-walled prominence, which is preceded by the formation of a number of hyphal branches, which have sprung from the mycelium, and have invested the carpogonium. A dense ball is thus formed, in the centre of which the carpogonium and terminal cell can scarcely be distinguished. These investing hyphæ form the principal mass of the apothecium, as well as the subhymenial layer and paraphyses. From the terminal cell spring a number of branches which terminate in asci. A number of the apothecia always remain small in the form of parenchymatous balls in which no carpogonium can be detected. Sig. Morini believes these to be the "spore-bulbils" of authors.

* Ber. Deutsch. Bot. Gesell., v. (1887) pp. 189-92 (1 pl.).

† Bot. Verein Lund, April 18, 1887. See Bot. Centralbl., xxxi. (1887) p. 321.

‡ Biol. Centralbl., vi. (1887) p. 719.

§ Rend. R. Accad. Sci. Bologna, March 27, 1887. See Bot. Centralbl., xxxi. (1887) p. 332.

Double Lichen.*—Herr W. Zopf has observed upon *Physma compactum* and on other Collemaeci, reddish-brown warty protuberances, which were found to be the imbedded flask-shaped perithecia of an Ascomycete, *Pleospora Collematum* n. sp. This fungus is not parasitic upon the lichen, but is in direct connection with the constituent alga, a species of *Nostoc*; and we have here a lichen made up by the symbiosis of two fungi with one alga. The mycelium of the *Pleospora*, easily distinguished by its yellow colour, penetrates the lichen to the base of the perithecia. When ready for fructification the perithecia emerge on the surface of the lichen in the form of reddish-brown protuberances; the thallus of the lichen surrounds the perithecia like a wall.

Microchemical reactions of Lichens.†—According to Dr. E. Bachmann, the chemical reaction characteristic of certain species of lichen, the appearance of a yellow colour, afterwards turning to red, when a drop of potash-ley is placed on the thallus, depends on the formation of very minute needle-like crystals, of a rusty or blood-red colour, collected in groups or in a dense felt. These are insoluble in glacial acetic acid, but are dissolved by concentrated hydrochloric acid with a yellow colour. This reaction occurs in *Urceolaria ocellata*, *Pertusaria lævigata*, *Lecidea lactea*, *L. Pilati*, *Lecanora subfusca* f. *chlarona*, *Aspicilia adunans* f. *glacialis*, *A. alpina*, *A. cinerea*, and *Parmelia acetabulum*. The yellow colour appears at once, the separation of crystals after a few minutes.

Hesse obtained from *Calycium chrysocephalum* a yellow crystallizable pigment, insoluble in and unchanged by potash-ley, to which he gave the name calycin. The same reaction is exhibited by *Physcia mediana*, *Candelaria vitellina*, *C. concolor*, and *Gyalolechia aurella*. Other microchemical tests are given, by which particular species of lichen can be distinguished from their nearest allies.

Emodin in Nephroma lusitanica.‡—In the medullary tissue of this lichen, Herr E. Bachmann finds a pigment closely allied in its products to chrysophanic acid, but still differing from it. It appears to be identical with emodin, known at present in the root of the rhubarb, and in the bark and berries of *Rhamnus Frangula*.

Introduction to the Study of Lichens.§—Mr. H. Willey's work under this title is a revised edition of his 'List of North American Lichens,' published in 1873, with an enumeration of all species discovered since that date, and descriptions of eleven new species. It contains also a condensed account of the main facts concerning the structure of Lichens and their classification. The plates represent the spores of North American genera.

Fungi.

Action of Pyrofuscin on Fungi.||—Herr P. F. Reinsch finds that a solution of pyrofuscin acts rapidly and destructively on living mould-fungi such as *Aspergillus*. He suggests that this discovery may have an important bearing in medicine, in the treatment of diseases due to parasitic fungi, such as croup; pyrofuscin being entirely without any injurious influence on living human tissues.

* Verh. KK. Zool.-Bot. Gesell. Wien, 1887 (1 pl.).

† Flora, lxx. (1887) pp. 291-4.

‡ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 192-4.

§ Willey, H., 'An Introduction to the Study of Lichens,' 43 pp., Suppl. and 10 pls. New Bedford, U.S.A., 1887. See Prof. W. G. Farlow in Amer. Journ. Sci., xxxiv. (1887) p. 75.

|| Deutsch. Chem. Ztg., 1887, 2 pp.

Identity of *Podosphæra minor* Howe, and *Microsphæra fulvofulera* Cooke.*—Miss M. Merry states that, in *M. fulvofulera* Cooke there is clearly a single ascus in each perithecium, thus placing it in the genus *Podosphæra*. It agrees with the description of *P. minor* Howe, thus necessitating the cancelling of *Microsphæra fulvofulera* Cooke.

New Section of Chytridium.†—Under the name *Chytridium Zygnetatis*, Herr F. Rosen describes a new species parasitic on species of *Zygnema*, especially *Z. cruciatum*. The swarmspores have a diameter of 3–4 μ , with a single cilium from six to ten times the length of the body. Each spore has a large eccentric oil-drop, and a less refrangible crescent-shaped body, probably composed of nuclein. On coming to rest the cilium shortens and winds itself round the spore, and then disappears, while the spore clothes itself with a thin and very extensible membrane. It then puts out a germinating tube, with a small vesicle at its apex, from which it branches into a mycelium within the host; on this are produced the nearly globular or slightly ovate zoosporangia, the formation of which is, under certain conditions, preceded by that of vesicles containing a drop of oil. Each sporangium is surmounted by a double crest of teeth or elevations, and contains from eight to sixty zoospores. The species is characterized by its great dependence on air, and has unusual capacity for resisting desiccation. It appears nearly allied in some respects to *C. Hydrodictyi*; in the mode of escape of the zoospores it resembles *C. Mastigotrichis*.

Herr Rosen proposes the establishment from this species of a new section of *Chytridium*, which he names *Dentigera*, with the following characters:—Unicellular *Chytridia* with a bladder in the cell of the nutrient alga, from which proceeds a branched mycelium, and a more or less nearly spherical zoosporangium, at the apex of which are (four) two-cleft teeth. The zoosporangium is either sessile on the portion contained in the nutrient cell, or one or two sometimes stalk-like vesicles are interposed. The swarm-spores are globular with an eccentric oil-drop and a single cilium. Resting-spores unknown.

To this section belong, in addition to *Chytridium Zygnetatis*, *C. dentatum* n. sp., parasitic on *Spirogyra orthospira*, and *C. quadricorne* dBy., parasitic on *Ædogonium rivulare*.

Cladochytrium.‡—Nowakowski included under this genus some forms of Chytridiaceæ with terminal or intercalary zoosporangia borne on branches of a mycelium partially or entirely projecting above the surface of the host; the zoospores producing again a similar mycelium without conjugating. Other forms producing resting-spores were believed by de Bary to be stages of development of the same fungus; and this has now been confirmed by Dr. M. Büsgen, who has followed out the whole cycle in *Cladochytrium Butomi*, parasitic on the stem and leaves of *Butomus umbellatus*. The development is characterized by the formation within the host-cell of swellings, within which are stored substances which are subsequently used up in the production of hyphæ and of resting-spores. In the same nutrient cell will sometimes be produced two kinds of swarmspore: one penetrates into the host and produces plants which bear resting-spores; the other kind is transformed almost directly into a second generation of zoosporangia.

In *Cladochytrium Flammulæ*, parasitic on *Ranunculus Flammula*, and *C. Menyanthis* on *Menyanthes trifoliata*, Dr. Büsgen has been able at present to detect the formation of resting-spores only.

* Bot. Gazette, xii. (1887) pp. 189–91 (1 pl.).

† Cohn's Beitr. z. Biol. d. Pflanzen, iv. (1887) pp. 253–67 (2 pls.).

‡ Ibid., pp. 270–83 (1 pl.).

Lophiostoma.*—Herr F. Lehmann contributes an exhaustive monograph of this genus, belonging to the Sphæriaceæ. Together with *Glyphium*, *Lophium*, and *Mytilinidion*, it makes up the family Lophiostomeæ. The following is the diagnosis given by the author:—Perithecia carbonacea, globosa v. ellipsoidea, ostiis pro ratione magnis, labiato-dehiscentibus v. poro rotundato pertusis instructa. Sporæ fusiformes v. oblongæ, rarius ovatae, 2–12-cellulares, v. rarius muriformes, hyalinae v. fuscae. The species are all epiphytic, more often on dead than on living plants, as many as 15 species on *Salix*; the other three genera of the family are most common on Conifers. In most species the only internal organs of reproduction are the asci; in a few, spermatia also have been found. In one species only are pycnidia known, producing stylospores.

The number of species at present known, and described in this monograph, is sixty-eight, of which twenty-six are new.

Phalloidei.†—Herr E. Fischer gives a monograph of the eleven known genera and seventy-three species of Phalloidei, chiefly exotic. He divides them first into two groups, the Phallei and Clathrei. The Phallei are again divided into Phallei mitrati, composed of the two genera *Dictyophora* and *Ithyphallus* (the latter including our native *Phallus impudicus*), and the Phallei capitati, also made up of two genera, *Mutinus* and *Kalchbrennera*. The Clathrei include seven genera not sharply defined, viz.:—*Simblum*, *Clathrus*, *Colus*, *Lysurus*, *Anthurus*, *Calathiscus*, and *Aserö*.

Peziza.‡—This genus, now numbering about 370 known species, has been split up into about 100 distinct genera. M. J. de Seynes proposes to reunite them as sub-groups of the old genus. Details are here given of the structure of several species.

P. tuberosa exhibits in its young mycelium the unusual phenomenon of dichotomy. Its hyphæ display one of the few examples among Ascomycetes of a parasitism or symbiosis with the cells of an alga, probably *Cystococcus humicola*. A difference in the mode of absorbing the nutriment from the host is exhibited, according as the parasitism belongs to the hyphæ of the mycelium or of the "cupule."

P. melastoma displays a peculiar mode of rejuvenescence in the cupule. If this organ is cut through, the uninjured hyphæ elongate themselves over the cut surface, and cover it with a young delicate tissue.

Helotium Willkommi.§—Dr. R. v. Wettstein gives a description of the geographical distribution of *Peziza* (*Helotium*) *Willkommi*, and the injury caused by it on larches. He regards it as nearly allied to *Helotium calyciforme*, forming a section of that genus, to which belong also *H. Abietinum*, *Ellisianum*, and *chrysophthalmum*.

Ptychogaster.||—M. Boudier points out that the forms included under the genus *Ptychogaster* are nothing but species of *Polyporus*, in which there is a large development of conidia in the interior of the tissue, which causes the individual to become sterile. In this way he proposes for a conidial form of *Polyporus amorphus* the name *Ptychogaster citrinus*; *Ptychogaster albus* is identified with *Polyporus borealis* or *P. destructor*, and *Ptychogaster*

* Nova Acta K. Leop. Carol. Deutsch. Acad. Naturforscher, l. (1886) pp. 45–152 (6 pls.). See Bot. Centralbl., xxxi. (1887) p. 265.

† Jahrb. Bot. Gart. Berlin, iv. (1887). See Hedwigia, xxvi. (1887) p. 113. Cf. this Journal, 1886, p. 833.

‡ Seynes, J. de, 'Rech. pour servir à l'hist. nat. des végétaux inférieurs,' iii., part 2, Paris, 1886. See Bot. Centralbl., xxxi. (1887) p. 70.

§ Bot. Centralbl., xxxi. (1887) pp. 285–7, 317–21.

|| Morot's Journ. de Bot., i. (1887) p. 7.

aurantiacus with *Polyporus sulfureus*; for the conidial state of *Polyporus vaporarius* the author proposes the name *Ptychogaster rubescens*.

Heterœcious Uredineæ.*—Mr. C. B. Plowright describes two new species of *Puccinia*, and also gives the results of some experiments on the Gymnosporangia.

Puccinia Phalaridis n. sp. The æcidiospores of this Uredine, known as *Æcidium Ari* Desm., occur on *Arum maculatum*; the uredospores and teleutospores on *Phalaris arundinacea*. The author states that it is specifically distinct from the plant described by Schneider as *P. sessilis*.

Puccinia arenariicola n. sp. The æcidiospores of this species occur on *Centaurea nigra*; the uredospores and teleutospores on *Carex arenaria*. It was conclusively demonstrated that *P. arenariicola* is distinct from *P. Caricis* and *P. Schœleriana*.

The author gives the details of some experiments on the Gymnosporangia, and states that the life-history of these fungi is not so simple a matter as the statements of Oersted would lead us to suppose.

Ustilago Treubii.†—Graf zu Solms-Laubach describes under this name a fungus which produces galls of two different kinds on *Polygonum chinense* in Java. One of these kinds of gall is composed of growths caused by the parasite proceeding from the cambium of the host. From the galls issue club-shaped outgrowths composed of parenchymatous tissue penetrated by an irregular string of meristematic vascular bundles. By the penetration into the tissue of a number of hyphæ proceeding from this structure a kind of capillitium is produced, among which are formed the minute spores, about $4\ \mu$ in diameter. This capillitium assists the dissemination of the spores by preventing their soaking by the tropical rain.

Fungus parasitic in Lecanium hesperidum.‡—M. R. Moniez finds that the parasite first seen by Prof. Leydig in the blood of *Lecanium hesperidum* is a fungus. He proposes for it the name of *Lecaniascus polymorphus*; its appearance varies considerably, according to the different stages of its mycelium. Its simplest stage is that of an ovoid body, $4\text{--}5\ \mu$ long, and it is then difficult to distinguish developed conidia or ascospores; in this stage budding is often observed. The mycelium sometimes presents a series of very distinct swellings, which the author regards as the homologues of conidia; in this condition the mycelium itself may be $50\text{--}60\ \mu$ in length. In highly developed individuals the mycelium, instead of being perfectly homogeneous, is entirely filled with a finely granular protoplasm; M. Moniez is inclined to think that this is a stage preparatory to the complete transformation of the mycelium into an ascus.

A somewhat similar fungus has been described by Metschnikoff in the blood of *Daphnia magna*, under the name of *Monospora bicuspidata*, and another by Bütschli from *Tylenchus pellucidus*.

Fungi parasitic on the Mulberry.§—Sig. A. N. Berlese enumerates as many as 176 species of fungus found on the mulberry in Europe and America, growing chiefly on the branches, and either parasitic or not. Of these 25 belong to the Hymenomycetes, 4 to the Discomycetes, 72 to the Pyrenomycetes, 27 to the Sphærospideæ, 41 to the Hyphomycetes, and 2 to the Myxomycetes. No species belonging to the Hypodermiæ is known to grow on the mulberry, and the same is true also of the fruit-trees

* Journ. Linn. Soc. Lond.—Bot., xxiv. (1887) pp. 88–100. Cf. this Journal, 1885, pp. 288, 503.

† Ann. Jard. Bot. Buitenzorg, vi. (1887) pp. 79–92 (1 pl.). See Bot. Ztg., xlv. (1887) p. 469.

‡ Bull. Soc. Zool. France, xii. (1887) pp. 150–2.

§ Bull. Soc. Ven.-Trent. Sci. Nat., iv. (1887) pp. 9–38.

belonging to the Aurantiaceæ. Of the Melanconia very few species are moricolous, and none of these are Italian.

Fungi parasitic on the Savin, Larch, and Aspen.*—Herr R. Hartig identifies *Cæoma pinitorquum*, parasitic on the savin, with *C. Laricis*, parasitic on the larch, and has established that both these species are represented by the teleutospore-form *Melampsora Tremulæ*, which hibernates on the aspen.

Colocasia Disease.†—The edible tubers of *Colocasia esculenta* are, in Jamaica, subject to a disease which Mr. G. Massee finds to be caused by the attacks of a hitherto undescribed fungus *Peronospora trichotoma*. It appears in the form of yellow spots corresponding to the vascular bundles, which are always first attacked, the mycelium spreading through the entire substance of the tuber along the cavities of the tracheids, from which it passes to the adjoining parenchyma. Two forms of reproductive bodies, conidia and resting-spores, have been met with; the former are produced only on hyphæ exposed to the air; the latter on threads in the substance of the tuber; the conidiophores form a delicate white bloom on the surface of the diseased tubers. The *Peronospora* is undoubtedly the cause of the disease, but is accompanied by two other fungi, *Heterosporium Colocasiæ* n. sp. and *Cephalosporium acrimonium*, parasitic on the preceding.

New Disease in Vines.‡—MM. L. Scribner and P. Viala describe a new fungus, *Greeneria fuliginea*, parasitic on vines. It has made its appearance in vineyards in the United States of America, and is found to attack the fruit just before it reaches maturity. A coloration is noticed which is rose-coloured in the white varieties of fruit, and reddish-brown in the dark varieties; this extends by concentric zones. The mycelium, which is very abundant in the berry, is whitish, and much branched and septated. The only reproductive bodies observed by the authors are peculiar; their structure is intermediate between the pycnidia and conidiophores. On account of the colour of the spores this fungus belongs to the Phæosporææ.

Tubercular Swellings on the Roots of *Vicia Faba*.§—Prof. H. Marshall Ward comes to the conclusion that the tubercles on the roots of *Vicia Faba* always contain a fungus, allied to the Ustilagineæ, which enters the root by the root-hairs. The ultimate branches of the hyphæ in the cells of the tubercle bud off gemmules, which are afterwards scattered in the soil. This process resembles the budding discovered by Brefeld in the Ustilagineæ. By means of cultures and observations the author found that the infection from the soil is probably due to these minute gemmules acting as spores.

Cohn's Cryptogamic Flora of Silesia (Fungi).||—In the second part of Herr J. Schroeter's account of the fungi of Silesia, contributed to this work, we find the conclusion of the description of the Myxogastres.

The Schizomycetes he divides into Coccobacteria, Eubacteria, and Desmobacteria. Under *Micrococcus* he describes a new species (*M. sordidus*), and two under *Streptococcus* (*S. lacteus* and *S. margaritaceus*). From Friedländer's *Pneumonicoccus* is founded the new genus *Hyalococcus*, with globular

* SB. Gesell. Morphol. u. Physiol. München, 1887, pp. 43-4. See Bull. Soc. Bot. France, xxxiv. (1887) Rev. Bibl., p. 76.

† Journ. Linn. Soc. Lond.—Bot., xxiv. (1887) pp. 45-9 (1 pl. and 2 figs.).

‡ Comptes Rendus, cv. (1887) pp. 473-4.

§ Proc. Roy. Soc. Lond., xlii. (1887) p. 356.

|| Cohn, F., 'Kryptogamen-Flora v. Schlesien,' Bd. iii. Pilze; bearbeitet v. J. Schroeter. Lief. 2; Breslau, 1886.

or elliptical cells, single or in pairs, rarely in rows of 4-6, inclosed in simple, distant, sharply-defined capsules. Besides *H. Pneumoniæ*, he regards *Pleurococcus Beigelii* as a second species. Of *Sarcina* three new species are described: *S. paludosa* in the water of sugar-factories, *S. rosea* in bogs, and *S. lutea*. *Bacterium termo* the author regards, not as a distinct species, but as the short-rod form of several filiform bacteria. *Bacillus* furnishes the following new species:—*B. sanguineus* from bogs, *B. Lacmus* in greenhouses, *B. melleus* on fæces, *B. pallidus*, *brunneus*, *corruscans*, and *melanosporus* on potatoes, and *B. fusisporus* in the water from sugar-factories. Under Eubacteria a new genus (*Cystobacter*) is described, consisting of short rods imbedded in a gelatinous mass, afterwards connected into filaments. The gelatinous mass divides into irregular lumps, which are afterwards inclosed in solid horny envelopes. It comprises two species, *C. fuscus* on hare's dung, and *C. erectus*.

The Chytridiacei are divided into three families, the Olpidiacei, Rhizidiacei, and Zygochytriacei. Belonging to the last is a new genus, *Urophlyctis*, in which the zoosporangia are seated on the living cells of the plant, and only the tufts of rhizoids remain imbedded in it; the resting sporangia are formed within the host by the conjugation of two similar cells. To this genus belongs *Physoderma pulposa* Wallr. Several new species are described, belonging to this family.

The order Zygomycetes comprises the Mucorinei and Entomophthorei, the former being again divided into the Mucoracei, Chætocladiacei, and Piptocephalidei. The Mucoracei include the Mucorei (*Mucor*, *Phycomyces*, *Sporodinia*, *Thamnidium*), Pilobolei (*Pilaira*, *Pilobolus*), and Mortierellei (*Herpocladium*, n. gen., *Mortierella*). The Chætocladiacei comprise the single genus *Chætocladium*; the Piptocephalidei the three genera, *Piptocephalis*, *Syncephalis*, and *Syncephalastrum*, n. gen. Under Entomophthorei are included *Empusa*, *Entomophthora*, *Tarichium*, *Conidiobolus*, and *Basiobolus*.

The new genera are thus characterized.—*Herpocladium*:—The twining uniformly thick sporangiophores develope, at the apices of the uniformly thick lateral branches, globular sporangia without a columella. The only species (*H. circinans*) was found on hare's dung. *Syncephalastrum*:—The capitulate sporangiophores, produced at the apices of branches, are densely covered with cylindrical sporangia, in which the spores are found in rows. The only species (*S. racemosum*) was found among *Aspergillus Oryzæ* on rice and bread.

The Oomycetes are divided into Ancylistacei (*Myzocyttium*, *Lagenidium*), Peronosporacei (*Pythium*, *Cystopus*, *Phytophthora*, *Sclerospora*, *Plasmopora*, *Bremia*, *Peronospora*), and Saprolegniacei (*Leptomitus*, *Saprolegnia*, *Achlya*, *Aphanomyces*).

Rabenhorst's Cryptogamic Flora of Germany (Fungi).—Parts 27 and 28 of this work are now published, elaborated by Dr. G. Winter, whose services to the publication are now lost by his death. In Part 27 the review of the suborder Spheriaceæ is completed with the genus *Xylaria* (twelve species) and its allies, and to it is appended a very useful clavis of the genera. This is followed by a description of the species belonging to the small suborder Dothideaceæ, completing the Pyrenomycetes. In Part 28 the Hysteriaceæ are commenced with a general account of the order, with its families, Hysterineæ, Hypodermiæ, and Dichænacæ (seventy-three species in all). This part finishes with a general description of the fourth order, Discomycetes, divided into the orders Pezizacæ and Helvellacæ, and of the suborder Phacidiaceæ.

Protophyta.

Micro-organisms.*—In his work ‘Die Mikroorganismen,’ Prof. M. C. Fluegge adopts the classification of de Bary and Frank, and passes in review all the pathogenic species of Hypodermii, Peronosporæ, Pyrenomycetes, and Mucorini, as well as those of Schizomycetes. In the case of *Aspergillus fumigatus* and *glaucus*, he states that the spores, if injected in sufficient quantities into the veins of a rabbit or guinea-pig, rapidly cause death. If rabbits, pigeons, or other small birds are placed in an atmosphere holding *Aspergillus* spores in suspension, the bronchials and kidneys become rapidly filled with the mycelial filaments; and the same is the case with *Erysiphe* and *Oidium*. With Grawitz, the author identifies *Oidium lactis*, *Achorion Schoenleinii*, *Trichophyton tonsurans*, and *Microsporon furfur* as forms of the same species.

The Schizomycetes are classified by Prof. Fluegge under four principal groups, viz.:—(1) *Micrococcus* (including *Staphylococcus*, *Streptococcus*, *Diplococcus*, *Ascococcus*, and *Sarcina*); (2) *Bacillus* (including *Bacterium*); (3) *Spirillum*; and (4) a group allied to Nostocæ, comprising *Leptothrix*, *Crenothrix*, and *Beggiatoa*. Each of the first two groups is again divided into pathogenic and saprophytic forms. The phenomena connected with gelatin culture are dwelt on in detail with each species. The author inclines to the view of Koch and Cohn with regard to the genetic distinction of the various forms, rather than to that of Zopf.

Rose-tinted Growth on Fresh Water.†—Herr J. B. Schnetzler, confirming the observation of Dr. Harz, describes a red substance floating on the surface of the Lac de Bret (Switzerland) due to the coccus-form of *Beggiatoa roseo-persicina*. In the same lake he found the dead bodies of flies attacked by the slender colourless leptothrix-filaments of the *Beggiatoa*, accompanied by its blackish zoogloea-form. From this latter the leptothrix was found to spring directly without any intermediate bacillus-form.

Sulphur-bacteria.‡—Herr S. Winogradsky proposes this term for that group of non-chlorophyllous protophytes distinguished physiologically by the property of reducing sulphur out of its solutions. In this group he includes *Beggiatoa alba* and its varieties, *Monas Okenii*, *M. vinosa*, *Clathrocystis roseo-persicina*, *Sarcina sulphurata* n. sp. (possibly identical with *S. rosea*), *Ophidiomonas sanguinea*, and probably others. His observations were made chiefly on *Beggiatoa alba* obtained from natural sulphur-springs.

The author finds that the presence of sulphates, especially calcium sulphate, in the water, is not only advantageous, but is absolutely essential for the healthy growth of *Beggiatoa*; but that, although, under such circumstances, reduction of the sulphates and formation of sulphuretted hydrogen takes place, the *Beggiatoa* takes no part in this reduction; the source of the sulphur in its structure is invariably the oxidation of sulphuretted hydrogen already present in the water. He confirms Hoppe-Seyler's statement that it cannot maintain its existence without access of free air. It appears, however, to require much less oxygen than most organisms; and where the supply of air is abundant it rapidly perishes. An excess of sulphuretted hydrogen also destroys it. By culture-experiments the author

* Fluegge, M. C., ‘Die Mikroorganismen,’ 692 pp. and 144 figs., Leipzig, 1886. See Bull. Soc. Bot. France, xxxiv. (1887) Rev. Bibl., p. 77.

† Bot. Centralbl., xxxi. (1887) p. 219. Cf. this Journal, ante, p. 787.

‡ Bot. Ztg., xlv. (1887) pp. 489–507, 513–23, 529–39, 545–59, 569–76, 589–94, 606–10 (3 figs.).

determined that water containing calcium sulphate is not capable of sustaining the life of *Beggiatoa*, unless the sulphuric acid is at the same time being reduced to the condition of H_2S .

The granules of sulphur found in greater or less abundance in the filaments of *Beggiatoa* are not, as stated by Cohn, crystalline, but consist of amorphous masses of the pure element of a soft consistency. It is completely soluble in carbon bisulphide. As soon as the filaments are dead the sulphur at once assumes the crystalline form, large crystals, formed from the contents of several cells, breaking through the cell-walls.

With regard to the further chemical process which takes place in the filaments of *Beggiatoa*, Herr Winogradsky came to the conclusion that the sulphur is there subject to a process of oxidation, resulting in the production of sulphuric acid, which, passing into the surrounding water, forms sulphates with evolution of carbonic acid; and this process goes on very energetically within the filaments. This is regarded by the author as a kind of respiration; though whether it altogether takes the place of the ordinary respiration, consisting in the oxidation of carbon compounds, he was unable to determine. This organism appears, at all events, to be able to exist in water which contains but a very small amount of organic matter. The entire removal of sulphur either entirely destroys its life, or possibly induces a resting condition. The source of the sulphuretted hydrogen in the water appears to be the reducing effect on soluble sulphates of the process described by Hoppe-Seyler as the "fermentation" of cellulose.

Micrococcus ochroleucus.*—Herr O. Prove finds in human urine a new chromogenous micrococcus, in colonies about 2 mm. in size, at first, and when light is excluded, colourless, but assuming, on exposure to light, a sulphur-yellow colour. The pigment is entirely insoluble in water, but easily soluble in alcohol with a yellow colour. This *Micrococcus ochroleucus* n. sp. is most easily cultivated on nutrient substances containing a considerable quantity of albuminoids, and with a slightly alkaline or a neutral reaction; solid nutrient substances are more favourable than liquid. Carbohydrates alone hinder or prevent the formation of mucilage and of the pigment. Under all these conditions the coccus-form remains unchanged, though the size of the individual micrococci varies. The formation of colonies is to a high degree dependent on the nutriment. In all cases in which there is a considerable separation of mucilage, especially, therefore, when there is abundance of albuminoids, chains of from 8-12 micrococci are produced; while in those cases where little or no mucilage is formed, or when supplied with carbohydrates only, or in certain saline solutions, the cocci are either isolated or are only associated in small numbers. In the former case it may be termed *Streptococcus ochroleucus*. The decompositions caused by the microbe vary according to the nutrient substance; if this is rich in albuminoids, the products are strongly alkaline; with carbohydrates or certain saline solutions they are, on the other hand, acid. For the production of the pigment abundance of nitrogen is required. A temperature of 36° C. is unfavourable to the vegetative development of the fungus; endogenous resting-spores are then produced, which germinate at 27°. Hard-boiled white of egg made slightly alkaline by dilute ammonia produced the most favourable results. The paper contains also a review of the other known yellow chromogenous microbes.

Nitrification.†—Sigg. A. Celli and F. Marino-Zuco state that in the course of analyses of water from the subsoil of Rome, amongst other

* Cohn's Beitr. z. Biol. d. Pflanzen, v. (1887) pp. 409-40 (1 pl.).

† Gazzetta, xvii. pp. 99-103. See Journ. Chem. Soc. Lond., 1887, Abstr., p. 858.

organisms a micrococcus of globular form (*Micrococcus cereus*) was discovered; this was found to be a very efficacious nitrifying agent. The authors quote experiments to prove that for the process of nitrification the presence of bacteria is not absolutely essential. It is further shown that among the organisms which liquefy nutritive gelatin *Bacillus saprogenus*, *B. fluidificans*, and *Micrococcus luteus*, when thrown on to sand in cultivating liquids, not only do not produce nitrates, but even destroy them completely; on the other hand, these same organisms, taken from potato-cultures, far from destroying the nitrates, are among the most active agents in producing them.

New (Indigenous) Microbe.*—M. E. Alvarez reminds us that the indigo of commerce is obtained by the maceration of the leaves of *Indigofera*, which contains a glucoside which is soluble in water; the solution is allowed to be exposed to the air. He finds from the experiments he has made, that indigo is a fermentation-product, and that this fermentation is caused by a special microbe, which is rod-shaped and much resembles the microbes of pneumonia and rhinoscleroma. These latter also produce the indigo-fermentation, while the indigenous bacterium has pathogenetic properties, causing either a temporary local inflammation, or death with congestions and fibrous exudations; the parts especially affected are the genito-urinary organs.

Certain Properties of Phosphorescent Bacteria.†—Prof. J. Forster, in conjunction with Dr. C. B. Tilanus, has made pure cultivations of bacteria which produce phosphorescence, and found that these micro-organisms have special properties.

By Koch's plate method those bacteria which under the Microscope appear as short thick rods, are easily cultivated if the gelatin contains 2–3 per cent. of salt. Bacteria obtained pure (bacilli) which do not liquefy gelatin, live and multiply in neutral or slightly alkaline nutritive media, even if very dilute, provided the necessary quantity of salt be present. In a gelatin made from fish they grew well with 6 per cent. of salt, while 7 per cent. decreased, and a still higher percentage altogether stopped their multiplication. On the other hand, an admixture with distilled water soon killed the bacilli, so that a weak salt solution was compulsory when a gelatin culture was placed on a cover-glass.

Pure cultivations of these bacteria, so long as atmospheric air is present, emit light in proportion to the size and age of the colonies, so that a plate-cultivation looks like the sky on a starry night. Plate or tube cultivations may be photographed in a perfectly dark room and a very clear picture obtained of the colonies. Although the light emitted even from large colonies is not strong, it is strong enough to suffice for a microspectrometric examination. Observed in the dark with the Zeiss-Abbe micro-spectrum ocular and 3 Leitz upper lens with a slit $1/3$ mm., it was seen that a colony 1 mm. in diameter gave an apparently continuous spectrum between λ 0.58–0.43, the brightness of which was greatest between 0.48–0.51, and diminishing more quickly towards the red end than towards the violet. The spectrum of a weak galvanic incandescent light of about the same intensity was brightest at λ 0.60, while at 0.50 no light was perceptible, so that the slight extension of the bacterial spectrum towards red and violet is dependent on the feebleness of the light of the spectrum. Colour differences in the spectrum are not recognizable, and

* Comptes Rendus, cv. (1887) pp. 286–9.

† Centralbl. f. Bacteriol. u. Parasitenk., ii. (1887) pp. 337–40.

examined without the prism the phosphorescent colonies seem greenish, or even greenish blue.

Transmitted light is absorbed by the colonies, although absorption-bands are to be perceived. Examined with Zeiss objective A, microspectrophotometer, comparing prism, two Engelmann incandescent lamps, three large Groves, both spectra with a slit of $s = s_1 = 20$ (wherefore $I = 0.01$) were approximately equal, and gradations of light were found which on interposing the colony required for given wave-lengths the following decrease in the slit of the comparing prism:—

$$\lambda = 0.66, 0.63, 0.60, 0.57, 0.54, 0.51, 0.48, 0.45.$$

$$s_1 = 12.1, 12.4, 12.0, 10.8, 9.9, 9.4, 7.7, 6.3.$$

By multiplying the numbers found for s_1 by 5, the per cent. equivalent of the absorption is obtained.

These micro-organisms moreover show a vital phenomenon in which they differ from other phosphorescent bacteria. Pure cultivations in salinated gelatin, bouillon, potato, &c., emit light equally well at temperatures from 0° – 20° C., but cease to give off light at from 32° . So far these properties agree approximately with the results of Pflüger, but if these bacilli be kept at 35° – 37° C. for some hours, their vitality is so impaired that inoculation from colonies thus treated can no longer be reproduced in a nutritive medium previously found quite suitable. Yet they will grow almost equally well in a refrigerator, and even if the test-tube be surrounded by finely-powdered ice and then placed in the refrigerator, that is to say, at a temperature of 0° C.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

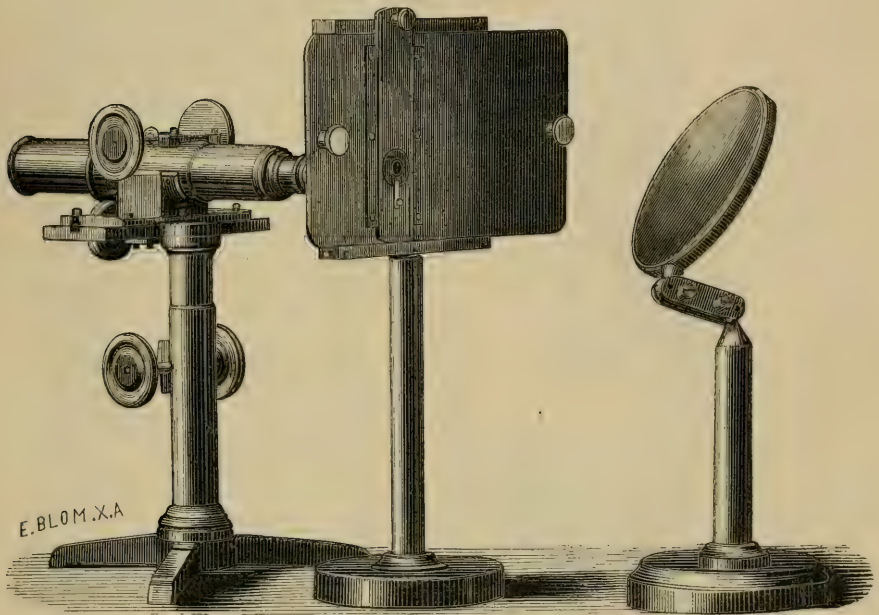
Schulze's Aquarium Microscope.—Prof. E. Schulze has designed and Messrs. Klönne and Müller have made the Microscope shown in fig. 235, for the observation of small aquatic organisms in an aquarium specially constructed for the purpose. There are three parts,—(1) the stand, the greater part of which is nickel-plated; (2) the aquarium; (3) the illuminating mirror.

The stand consists essentially of a Microscope-tube which is supported in a horizontal position upon a tripod in such a way that it can be moved in three different directions by rack-and-pinion. The column of the tripod carries a rack-and-pinion by which the tube is moved vertically. On the tube which carries the rack is a sliding-piece with a second rack for the horizontal movement from right to left; upon this slide the Microscope is fixed in a horizontal position and can be moved backwards and forwards in a tube provided with rack-and-pinion. There are therefore three movements, vertical, horizontal-lateral, and horizontal-sagittal, so that the organism observed can be followed by the tube as it moves upon the glass wall of the aquarium.

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photo-micrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

The aquarium consists of a stand with a frame which carries the aquarium proper, 10 cm. in breadth and height, and 10 mm. in thickness; this may be replaced by others. The frame is made of brass lacquered black. The aquarium itself consists of a horseshoe-shaped piece of glass, both sides of which are closed by plates of cover-glass leaving the upper end open. It is thus possible to observe an organism upon either of the

FIG. 235.



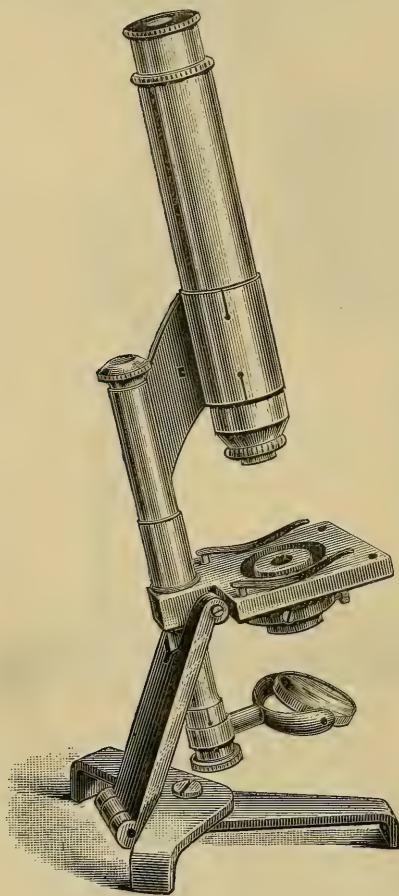
two thin sides with an objective giving a linear amplification of 200–300. To screen off the superfluous light and the numerous reflections in the aquarium, the frame carries a diaphragm arrangement which can be applied on either side at pleasure. This consists of a sliding-plate which moves in two horizontal guides; it is divided into three parts, and has an oblong opening in one of the divisions. In this opening a thin plate slides and can be clamped at any point. In this plate again is a circular aperture, which can be closed to a greater or less extent by various diaphragms kept in position by a small spring.

If an animal is on the upper left-hand corner of the side turned towards the Microscope, the sliding-plate is first moved so that the vertical longitudinal opening lies in the left-hand third, the small plate is then set so that its opening lies in the upper third. If, on the other hand, the animal is on the right-hand side, the larger sliding-plate is moved so that the longitudinal opening lies on the right, and if the animal is towards the bottom, the small slide with its opening is moved downwards. The two sliding-plates are now so directed that light may be thrown by the mirror through the aquarium and upon the animal on the front side. The aperture can be further reduced by diaphragms.

The mirror is concave, 10 cm. in diameter, and fixed upon its stand with a ball-and-socket joint so that it can be adjusted in any position.

Giles's Army Medical Microscope.—Mr. G. M. Giles, Surgeon-Naturalist, Indian Marine Survey, writes, that "to the military surgeon, or explorer, who has to carry a Microscope with him, bulk and weight are considerations of the first importance. Even in peace time the former is

FIG. 236.



so often on the move, that he early learns to dispense, as far as possible, with bulky and heavy articles." Hence he was "anxious to devise an instrument which while it should pack into a moderate-sized box, should not be open to the objections of some of the existing forms, and in fact should be applicable to all the work of the military surgeon in station as well as in camp life." This is shown in fig. 236.

"The great obstacle in the way of making a sufficiently portable stand is that, in all previous patterns, the stage is permanently fixed to the body, and so has to be limited in size in order not to unduly increase the cross measurement of the box. This difficulty has been met by making the stage and foot in one piece, arranged so as to fold up flat, for packing (fig. 237), the body and pillar being keyed on to the stage and fixed in position by the arm carrying the mirror being used as a nut.

When set up, the instrument is about 9 in. high, and the stage measures 2.5 in. by 2.2 in., and is quite adequate to all ordinary pathological work. When folded up, it packs, including the centering substage described below, into a strong box 5.8 in. by 3.2 in. by 2.75 in. outside measurement. By making the box a little longer

(7 inches) an extra objective, double nose-piece, and polariscope can be carried in addition, the last-mentioned piece of apparatus being a special desideratum to the geological explorer.

Every microscopist knows how much definition is improved by the use of the German form of diaphragm, the aperture of which is level with the stage, and does not markedly exceed the field of the objective. In a portable instrument, these can hardly be used except in a centering substage, of which I have devised a very simple and inexpensive form for the purposes of this instrument. It consists of a short, stout brass tube, screwing into the opening in the stage. The tube carrying the diaphragms, polarizer, condenser, &c., is provided with a double collar, and is supported within the larger tube by means of three screws. One of these has a thread only at its point where it screws into the inner tube, its shaft working freely in a hole in the outer. Between the two tubes it pierces a small piece of solid

rubber which acts as a spring. The other two screws are provided with milled heads, and work in holes tapped in the outer tube, their points alone being free from thread, and made to fit exactly into the slot of the double

FIG. 237.

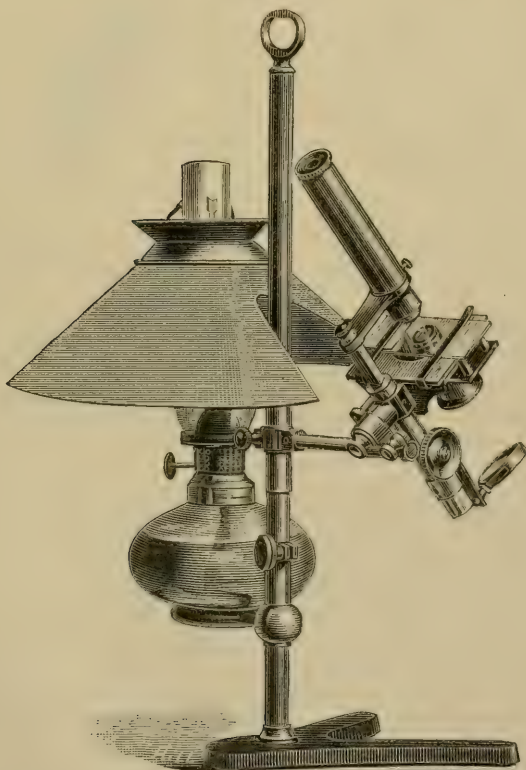


Elevation of stage and foot when folded. *a*, transverse limb of foot; *b*, antero-posterior ditto; *c*, pillar; *d*, stage.

collar, which they press against the resistance of the rubber spring. The second objective is carried within the tube of the Microscope, screwing for packing on to the upper side of an adapter. This also serves to carry the analyser when the polariscope is in use."

Nelson's Portable Microscope.—Mr. E. M. Nelson exhibited at the November meeting of the Society a new portable Microscope (figs. 238 and 239), made by Messrs. Powell & Lealand from his drawings.

FIG. 238.

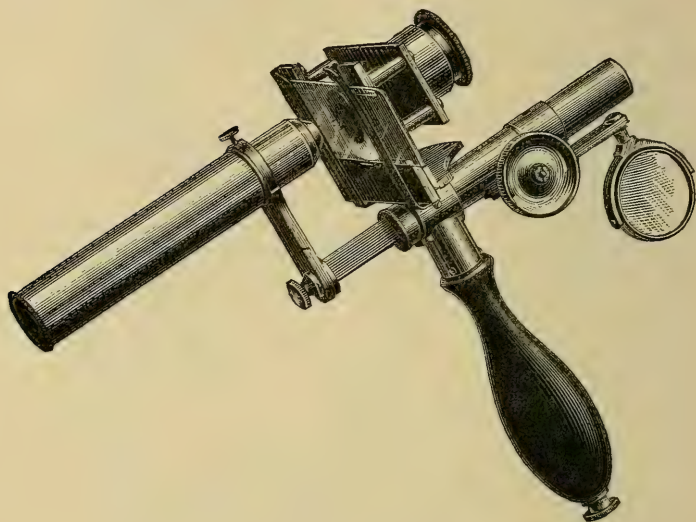


The instrument is adapted for three different modes of use, viz.:—(1) As a small table Microscope for home use (a very useful adjunct to a large instrument); (2) as a portable Microscope for the exhibition of objects at

Societies, &c. (fig. 238); (3) as a field Microscope and class demonstration instrument (fig. 239).

The instrument has two objectives, a $\frac{4}{10}$ in. and a 1 in., which, with two eye-pieces, give the following powers:—35, 70, 100, 200. The $\frac{4}{10}$ is of 0.65 N.A. The highest power, therefore, is equivalent to a $\frac{1}{2}$ in. of

FIG. 239.



80° with a C eye-piece, or a $\frac{1}{4}$ of 80° with an A eye-piece, on an ordinary full-sized English Microscope. The lowest eye-piece is on the Abbe compensating principle.

In the mechanical portion of the instrument are several new features. The design of the Microscope is that which is generally known as the bar movement. It has a rack-and-pinion coarse-adjustment, and no fine-adjustment, thereby following the dictum of the great master (the late Hugh Powell), who said, "In an elementary Microscope a good coarse-adjustment without any fine is better than one with a second-rate fine and no coarse-adjustment." The truth of this statement is daily verified in the shaky condition of the fine-adjustments of students' Microscopes which are fitted with a direct-acting screw fine-adjustment and a sliding-tube coarse-adjustment. The body of the Microscope is 3 inches long. The stage is of Mr. Nelson's horseshoe pattern, and the spring clips are those of Hugh Powell. Although strongly opposed to all kinds of clips, Mr. Nelson found they were necessary in this instance to permit of the complete inversion of the instrument. The great difference between these clips and those of the usual form is that these being fixed underneath the stage, allow a smoothness of action to the slip which is totally foreign to the others.

To the underneath side of the stage is fixed the substage which carries an achromatic condenser, focusing by means of a sliding-tube.

The stage and substage rotate on an axis, so that they may be turned into the plane of the trunk for packing.

There is a plane mirror mounted on a crank arm. The foot is circular, rests on three points, and has an upright rod capable of extension like a

bull's-eye stand. On the top of the upright there is a short horizontal arm, to which the Microscope is attached.

For portable and exhibition purposes the instrument fits on to the Microscope lamp-stand, the same apparatus being used to attach it as in the first case (fig. 238).

When the Microscope is required for field or class purposes this attaching piece is taken off, and is replaced by a handle (fig. 239). The handle and the attaching piece are so arranged that the Microscope cannot shake loose or twist off, or get off the square.

When the instrument is used in the field, the mirror is swung to one side, and the condenser is pointed to the sky.

Woodhead's Microscope with large Stage.—This Microscope, devised by Dr. Woodhead and made by Mr. H. Crouch, has a stage of unusually large size, $11\frac{3}{4}$ by $9\frac{3}{4}$ in., for the examination of sections through entire organs.

Selenka's Electric Projection-Lamp for Microscopic Purposes.*—Prof. E. Selenka describes a Projection-Microscope constructed for him by Herren Reiniger, Gebbert, and Schall, of Erlangen, "which, by its practical and convenient construction, fulfils its purpose in a remarkable manner." He describes the apparatus fully "in the expectation that it will soon be more largely used; for thousands of microscopic objects can in this way be used without difficulty for demonstration, and although there is no question that the ordinary diagrams and lithographs have done, and will do good service, yet the impression made by the exhibition of the object itself is much more vivid and permanent than that produced by a representation."

To show what objects are of value for demonstration in zoological lectures, for a large circle of students, the author states that at a distance of 5 metres from the screen the contractile vacuoles and the so-called streaming of granules in living *Amœbæ* are clearly visible, as are also the ciliary movements and ingestion of food by Infusoria. "In stained calcareous sponges the flagellated chambers and spicules may be shown, as may also the cellular structure of the arms of hydroid polyps, and the entire sexual apparatus in the proglottides of tape-worms. *Trichinæ*, *Echinorhynchi*, Trematodes, worm-larvæ, small Annelids mounted in balsam, Rotatoria, and Copepoda in the living condition give incomparable images, as also the larvæ of Echinoderms and Molluscs. Sections of the embryos of vertebrates stained with carmine or hæmatoxylin make excellent objects to show the development of the vertebræ, heart, nerve-fibres, sense-organs, amnion, allantois, and urogenital system. I can show without any difficulty the cleavage of the egg, gastrulation, rudiments of the cœlom, and even the formation of yolk-rays in the segmenting ovum, and the filamentar loops in the dividing nucleus. Charming images are given by the membrane between the digits of the foot of the living frog or the gills of the *Salamander* larva, the tracheæ of the flea or the louse, &c. And how quickly and simply is the demonstration effected! In those lectures in which I intend to project microscopic objects, the discourse proceeds without interruption, and the last five to ten minutes are used for the demonstration. At a given signal the projection-lamp is put into action, and then all that is required is the complete darkening of the auditorium. This is rapidly and easily effected by lowering canvas blinds covered on both sides with a thick coating of oil-paint of any desired colour. The blinds are raised and lowered by means of a winch; the demonstration is made without any assistance.

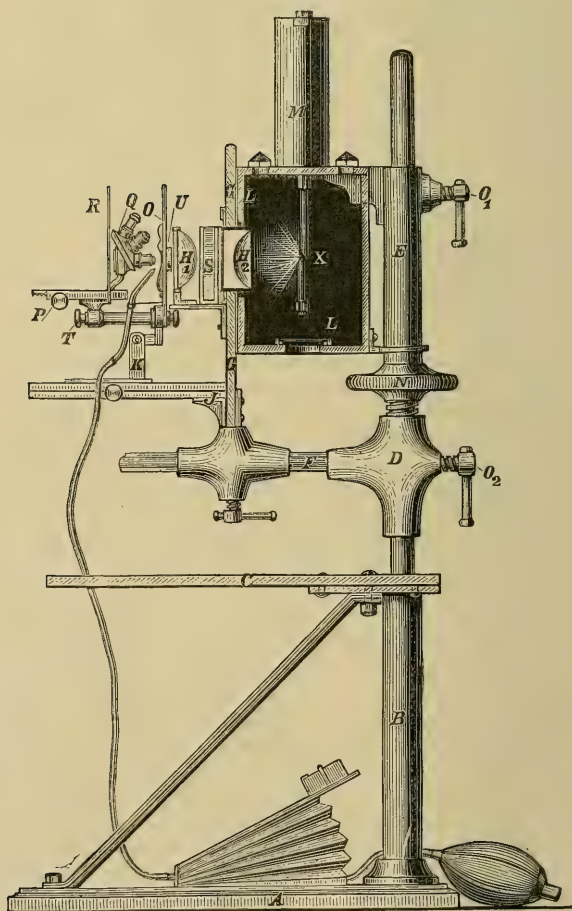
The light is obtained from a dynamo machine driven by an engine of

* SB. Physikal.-Med. Soc. Erlangen, 1887, Heft 19, 8 pp. (1 fig.).

two horse-power, and supplying an arc light of about 1200 candle-power. This is sufficient for a linear amplification of 1000; but for oil-immersion or for high-power dry systems an illuminator is required. An achromatic condenser has accordingly been designed by Prof. Abbe, as the ordinary chromatic Abbe condenser cannot be used for the purpose. The brightness of the image is increased to an extraordinary extent by the achromatic Abbe condenser, and, so far as I can estimate, is nearly equal to that which, without this system of lenses, would only be attained by an arc light of 2500 candle-power. Since the condenser is only used with the higher powers, it requires a simple adjustment by which it can be removed. The brightness of the image can, of course, be considerably increased by using a more powerful source of light.

The construction of the lamp (fig. 240) has been left entirely to the

FIG. 240.



mechanician. A is a rectangular plate of cast iron into which the cylindrical iron rod B is set, and fixed by two iron stays. At the height of the table is a shelf C for the objects not in use. Above the shelf are the two iron

tube-pieces which slide upon the rod B and are clamped by the screws O_1 and O_2 ; the lower and shorter of these tubes D carries on the horizontal ribbed arm F, the plate G with the condensers H_1 and H_2 , and also the plate J with the Microscope K. To the upper and longer tube E is fixed the light-chamber L with the arc-lamp M screwed to its upper side.

The light used is that known as the Piette-Krizek lamp which, on account of its accuracy of regulation, has been very largely used, and for this very reason has been better tested than many other systems, and which, in spite of its excellent construction, is moderate in price. Since, however, with the best regulated lamps the point of light after long use is invariably shifted slightly upwards or downwards, the piece which carries the lamp and the light-chamber is made to slide up and down the fixed part which supports the condensers and the Microscope, so as to bring the point of light back into the axis of the condensers. This movement is effected by means of a nut N which works between the parts D and E upon the screw-thread of D, so as to raise or lower the light-chamber L and the lamp M, and bring the point of light X to any desired height. A rotation of E with the light-chamber is rendered impossible by bringing the plate G close against the front side of L and making it fit in grooves upon the front of the light-chamber, so that the two parts can only move upon one another in a vertical direction and keep the source of light completely inclosed.

The light-chamber is made of strong oak, and to the top is screwed the lamp from which the two iron rods which carry the carbons project into the chamber. In the top are also, besides the aperture for the carbon-holders, several ventilating holes to carry off the hot air; these holes are covered with tin caps to screen the light. The left side of the chamber is entirely closed, while the right side is provided with a door to allow the insertion of new carbons, &c. In the centre of the door is a circular hole closed with dark glass through which to observe the glowing carbon points. At the bottom of the chamber is a circular opening through which the shelf for the objects is illuminated, and which serves for ventilation; above the opening is a dark glass to moderate the light and to catch the ash which falls from the carbons.

The front side of the chamber has an aperture into which the condenser-holder projects. This aperture is made large enough to allow free play for the chamber; the source of light being brought into the axis of the condensers, as was said above, by a motion of the chamber. In the axis of the lenses H_1 and H_2 , is the Microscope K, supported on the plate J which is attached to G.

For the lenses I use the ordinary horseshoe stand with the following alterations: (1) the upper piece for rotating the Microscope is unscrewed from the foot, turned through 180° , and fixed again to the foot so that the stage is not over the horseshoe, but projects behind it; the horizontal Microscope can then be brought as near as is required to the large condensing lens H_1 , which with low powers is necessary to secure a colourless image. (2) Instead of the small thick stage, a large plate O with diaphragm U and two clips is used; (3) in place of the tube moved with rack and pinion, there is an arm P, moved in the same way and carrying the nose-piece Q, which allows a rapid change of objectives. A metallic screen R, of 15 cm. diameter, serves to arrest the rays which pass beside the objective; this is placed immediately behind the nose-piece.

With high powers the object must be brought near to the focus of the condensers, while with low powers it must be moved beyond the focus and

brought nearer to the condenser. This movement is effected by a sliding motion of the stand K between two wooden guides, by means of rackwork.

Between the two condensing lenses it is necessary to insert a glass trough S, with plane sides filled with concentrated alum solution, to prevent the over-heating of the object. Thick or dark-coloured objects are very easily over-heated; an energetic and invariably sufficient means of cooling is obtained by a current of air directed upon the surface of the object or upon the cover-glass. Compressed air is obtained from a loaded india-rubber bag (above A). The delivery tube is of brass, with an aperture of $1/2$ –1 mm., and is fixed to the stand at an angle of 45° on the under side of the objective; the distance of the aperture from the cover-glass being about 1 to $1\frac{1}{2}$ cm.

The coarse-adjustment is effected by the rackwork on P, the fine-adjustment by the micrometer-screw T. The objects are held by one or two of the usual clips against the vertical stage.

The nearer the lamp is to the white paper screen, the brighter will be the images, but the less the amplification. After several trials a distance of 5 metres between the object and the screen has proved the most convenient. By using a stronger source of light, this distance may easily be increased to 6–10 metres.

To bring the projected image as near as possible to my audience, I place the electric lamp in the middle of the amphitheatre, and the screen in front of the first row of seats, an open passage being left between the lamp and screen. There is no objection to the image being seen obliquely foreshortened by those of the audience who are at the sides; it scarcely loses in clearness thereby.

White paper does not give nearly such bright and clear images as a plaster surface. This is made by bending an iron band into a circular or rectangular form, making a network of wire across it, and placing the whole upon a glass plate which has been rubbed over with powdered talc. Alabaster plaster is poured upon the network, and when it is cool the whole mass is lifted off. The projection plate should have a diameter of 1·2 to 2 metres. Trials with transparent screens, such as oil paper, tracing paper, or ground glass plates gave unsatisfactory results.

After numerous experiments it has been found that the finest images are given by those objectives which have been made for a long tube, especially the so-called photographic objectives. It is not advisable to make use of an eye-piece for projection purposes.

To cut off all extraneous light, it is a good plan to place over the condensing lens H_1 and the alum trough S, a light cardboard case which is prolonged into a cardboard tube towards the stage of the Microscope in the direction of the beam of light.

Finally it may be mentioned that it is possible to use a horizontal stage. The beam of light is then reflected upwards by the ordinary plane mirror, and again deflected into a horizontal direction by a prism of flint glass, which rests against the upper nose-piece aperture.

Of the objectives which I have employed, the following give the best defined images:—Hartnack, objectives 1 and 2; Seibert, 1 in., $1/2$ in., and $1/4$ in. photographic objectives; Winkel, objective 7; as well as water- and oil-immersion objectives of various makers.

Absolutely colourless images of extraordinary clearness are given by the combination of the new Zeiss apochromatic objectives with the corresponding 'projection-eye-pieces.' Though this combination is unrivalled for photographic purposes, it is not convenient for demonstration, since the image is too faint and of too limited dimensions."

The whole apparatus is supplied in this country by Mr. K. Schall, of

55, Wigmore Street, W. It was exhibited at the meeting of the Medical Congress at Dublin in August, where it was reported * to have "proved itself infinitely superior to the oxyhydrogen limelight as a means of class demonstration."

At the Hygienic Congress in Vienna, Prof. S. Stricker also gave demonstrations with the electric Microscope, which, it is claimed,† conclusively prove the value of this new method of medical teaching. Among other things, Prof. Stricker exhibited photographs by transmitted light, with 1400 linear amplification, and a section through the spinal marrow of an adult man, in which the ramifications and crossings of the nerves could be most clearly seen. A demonstration was also made with incident light and an amplification of 72,000 times, the object being the exposed pulsating heart of a turtle. "The whole action of the heart could be followed in the most surprising manner, the flow of blood to the great aorta could be observed, and an insight obtained into the inner life to an extent which is seldom realized by experienced students of hygiene."

Leach's Lantern Microscope.‡—At the Soirée of the Manchester Microscopical Society, on the 29th January, 1887, Mr. W. Leach exhibited a Lantern Microscope, attached to a photographic camera, the bellows body of which opened out to thirty-six inches. With a 4/10 in. objective, images were shown upon the screen magnified eighty diameters, and "were seen well defined, brilliantly and equally lighted, without covering being placed over the camera, notwithstanding the gaslights overhead and all around the room. The field was noted for being as even as a sheet of writing-paper. When the lantern door was opened much astonishment was expressed, when it was seen that all this illumination was obtained from a small paraffin lamp burning with a single half-inch wick."

The author in his paper describes his experiments and results as follows:—

"It is some eight or ten years since I felt dissatisfied with the results which I was then able to obtain with the ordinary lantern arrangements for projecting microscopic objects upon the screen, and began to make experiments with the aim of getting more successful illumination. The amount of light transmitted through the bi-lens lantern condenser being in the inverse ratio of the square of the distance between it and the luminant, I tried to shorten the space by the well-known device, first introduced by the Rev. W. T. Kingsley about 1855, of adding a third lens to the other two, and thus shortening the compound focus. But this I soon found was, without further addition, of no use whatever, as the cone of rays at its apex was so large, or the light passed through it at so great an angle, that it was impossible to transmit it through both the object and the objective. Thus the beam of light, however strong it might be at the focus of the condenser, did not reach the screen, and therefore served no purpose except that of boiling the object in the balsam used in mounting it.

I next placed another lens in the cone of rays a little beyond the focus, and hoped by this means to so lessen its diameter as to make it capable of transmission. This was a sort of substage arrangement, and was found to be a great improvement when the lens was of the right focus for the objective, and was situated at the right distance from both it and the object. To be able to thus place it at the right distance from both, meant having a substage lens for all objectives differing widely in power, the focus of each being such as the power and construction of the others might require.

* Brit. Med. Journ., 1887, Aug. 27, p. 470.

† Central-Ztg. f. Opt. u. Mech., viii. (1887) p. 250.

‡ Brit. Journ. of Phot., xxxiv. (1887) pp. 153-4.

Rack-and-pinion movement was also found to be necessary, so that the rays might be properly focused on either side of the object. The lenses used should be large enough to take in the whole cone of the principal condenser, and for the higher powers it is requisite to combine two or three of them together. The highest as well as the lowest powers may thus be made useful for lantern projections. Mr. Kingsley stated in his paper upon this subject at the time I have just named that he could transmit as much light through the higher as through any of the lower powers, and gave diagrams of the arrangement which he made use of.

So much for the past; now we come to the present. The objectives which I shall use this evening are 2 in., 1 in., and $\frac{4}{10}$ in. The 2 in. requires the substage lens to be a little over 2 in. focus, $1\frac{3}{8}$ in. diameter, plano-convex. A similar kind of lens, $1\frac{3}{4}$ in. focus, proves in my hands to be a good all-round condenser for all powers from $1\frac{1}{2}$ in. up to $\frac{4}{10}$ in. objectives. By liberal use of the rack-and-pinion and of the concave lens to be presently described, this substage lens gives the most brilliant results throughout this wide range of powers. The $\frac{1}{4}$ in. objective, when it is desirable to use it for photographic purposes, requires two lenses; the back one to be $2\frac{1}{2}$ in. focus and $1\frac{3}{8}$ in. diameter, and the front one $1\frac{1}{4}$ in. focus and 1 in. diameter, both plano-convex. This also makes a good condenser for the $\frac{4}{10}$ in. objective. All the lenses must have the curved surfaces turned towards the lantern. The luminant goes to within $1\frac{3}{4}$ in. of the back lens of the principal condenser with the 2 in., and to within 2 in. with the other two objectives. I have tried it closer than this, by using a back lens of shorter focus, without advantage—in fact, considerably otherwise. If a flint concave lens is placed in the cone of rays about one or two inches before the really active ones begin to cross, the light is much improved. The concave which I use is about 6 in. focus and $1\frac{3}{4}$ in. diameter. It is so placed in the tube which carries the other substage lenses that its distance from the principal condenser can be altered so as to modify the length of the cone of rays to adapt the focus of the other lenses to the objective when they do not exactly meet its requirements. The concave lens was, I believe, first introduced into the lantern cone of rays by J. T. Taylor in 1866, for the purpose of parallelizing them, but I do not use it for any such purpose in this lantern Microscope. In my lantern polariscope I imitate Taylor in the use of the concave, but here the purpose served is quite a different one. My lantern condenser is $3\frac{3}{4}$ in. diameter, with a plano-convex $3\frac{1}{2}$ in. diameter and 7 in. focus, mounted upon the back of the tube which carries the other lenses.

In lantern Microscope projection three things are essential. The first is brilliant illumination, the second large amplification, and the third clear display of detail. But brilliant illumination does not mean a dazzling display of light upon a large white screen, showing a dark, patchy outline of an object, without detail. Objects shown in this way are far inferior to an enlarged woodcut. The light must be made to enter the object so as to bring its structure out to the eye of the onlooker. But no amount of light will do this if its dimensions are too small for the crystalline lens to form an image of it upon the retina. With high-power objectives the light must, in the nature of things, be greatly subdued. Still, a large image, moderately but properly lighted, can be far better seen than a small one many times as bright. An object may in fact be too bright to be seen. If rays of great angle are too powerfully converged upon it the image becomes as bright as that part of the screen which represents nothing but bare glass. It is in this case just like an over-exposed photograph, flat and without contrast. The image may, therefore, be too bright for the screen, just as it

may be too black for it, and what we have to aim at is that mean which will show the detail in one without making the other too glaring.

Having made our arrangements according to what is here advanced, we ought to be able to show the various minute organs of insects and the details of vegetable and animal tissue. I have shown very finely the blowfly's tongue over sixteen feet long, and the male flea with its outstretched legs twelve feet long. Sections of spine of *Echinus* may be magnified to seven or twelve feet diameter, and sections of a rat's tail eight feet diameter. Mites in cheese with such powers become large as guinea-pigs, and *Volvox globator* gracefully rolling over a sixteen-feet screen are larger than tennis-balls. The cornea of the *Dytiscus* is a most wonderful object when shown eight to ten feet in diameter.

When I say that such things can be shown in such enormous sizes, you must not suppose that the display will be like an outline map, black and skeleton-like in appearance upon a white ground. Instead of that the small capillary blood-vessels in anatomical sections, the various appendages of the feet of insects, the hairs of plants, the rings of insect tracheæ, the eyes of insects with the light gleaming through each facet of the cornea, with other equally minute details, can be displayed to an audience with very great satisfaction. That, you must admit, far surpasses anything ever achieved by the old lantern Microscope, and we boldly challenge any admirer of the old method to show that he is not now left as far behind by the new one as the old stage-coach is left behind by the railway train.

I think I ought to say that my lantern Microscope has been made by myself. All its details have been worked out by myself. I have, of course, utilized any old photographic lens mount, or old Microscope fittings which I could get to work up into my arrangement, so as to save mechanical labour. It fits, as you will see, into the ordinary lantern front. The alum trough goes into the place which holds the slider when the lantern is used for ordinary pictures. The stage is one of Dancer's old lantern Microscope stages, but is modified so as to hold and enable me to change the substage condensers, which can be done more easily and with less loss of time through mine than it can be done through any other arrangement. The compactness of the instrument is also something worth considering.

Since the foregoing pages were written I have fitted up a 1-inch objective which is very satisfactory. It transmits a large beam of light, and gives a flat field of great size, the central and marginal definition being fairly good at the same time. As a rule the best ordinary objectives give no definition beyond a small circle in the middle of the field."

Newton's Electric Polarizing Projection-Microscope.—This instrument, constructed for the Science and Art Department, South Kensington, by Messrs. Newton and Co., and exhibited at the *Conversazione* in November, is of similar construction (with only necessary modifications) to the oxyhydrogen projection Microscope which was described by Mr. L. Wright in this Journal, 1885, p. 196. It will give good results with immersion lenses up to 6000 diameters and upwards; the magnification possible depending chiefly upon the *opacity* of detail necessary for a large screen image.

In addition to the usual polarizing effects it is fitted with lenses for exhibiting the brushes and coloured fringes in crystals, and also for use with the oxyhydrogen jet.

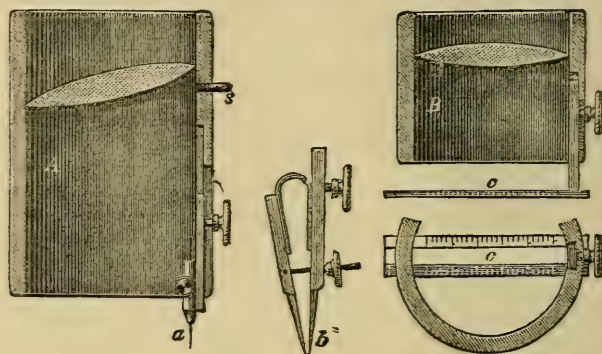
Lehrke's Lens-holder.*—Herr J. Lehrke's arrangement (fig. 241) consists of a cylindrical metal- or horn-mounted lens, 2-4 cm. long, and

* Zeitschr. f. Instrumentenk., vii. (1887) pp. 218-9 (4 figs.).

2-3 cm. in diameter, and magnifying from 1-2 times, whose side is provided with a contrivance for holding a copying needle, a protractor, &c.

While hitherto the architect, in using millimetre paper, must hold separately in his hands a magnifying glass and needle, while the engraver holds the engraving tool inclined in one hand and the magnifying glass in the other, or must work under a large lens standing on three feet, it is now possible, by a firm connection between the lens and needle or other

FIG. 241.



instrument, to draw directly with one hand, and under the lens. One of these lenses is shown in section at A, the glass is set obliquely, the needle *a* being in the focus. The stud *s*, projecting a little near the glass, is for the purpose of preventing the instrument from leaving the position coinciding with the plane of the drawing. For architects and engineers is provided a small compass *b* (about 2 cm.), for laying off parallel divisions, for making smaller scales, and the like. In these cases it is substituted for the needle. In like manner, for reading parallel divisions, for estimating areas, or revising maps, a finely divided, prismatic, ivory rule *c* can be placed under the glass B. In this case the plane of the lens must be perpendicular to the axis of the tube. For draughtsmen a parallel drawing-pen, something like *b*, is used, which gives several lines at once, perfectly parallel and close together; or a drawing-pen with which the smallest names, such as boundary stones and figures, can be made neatly and exactly. Thus a whole series of instruments can be used with the lens. For instance, a naturalist can use with it a knife or other instrument.

HENNEGUY.—*Sur un nouveau Microscope de voyage construit par Dumaige.* (On a new travelling Microscope made by Dumaige.) *CR. Soc. Biol.*, IV. (1887) No. 7.
 Linnæus's Microscope.

[At the Pittsburg meeting of the American Society of Microscopists, "a very curious Microscope, once the property of Linnæus, was described by C. C. Mellor," President of the Iron City Microscopical Society.]

Microscope, VII. (1887) p. 271.

(2) Eye-pieces and Objectives.

Thickness of cover-glass for which unadjustable objectives are corrected.*—Prof. S. H. Gage communicated to the Pittsburg Meeting of the American Society of Microscopists the following paper:—"As the thick-

* *Microscope*, vii. (1887) pp. 292-3.

ness of the cover-glass as well as the tube-length has an important influence on the perfection of the microscopic image, and as almost all objects for microscopic examination are covered, the objective must be adjustable to compensate for the various thicknesses of cover-glasses used, or some uniform thickness of cover-glass must be selected, for which the optician corrects or adjusts the objective once for all. The thickness for which such unadjustable objectives are adjusted varies with the different opticians, as shown in the table below. The information in the table was obtained by direct inquiry as for the information concerning 'tube-length' hereinafter mentioned.*

TABLE showing the Thickness of Cover-glass for which unadjustable objectives are corrected by various Opticians.

0.25	mm.	J. Green, Brooklyn.
		J. Grunow, New York.
		Powell & Lealand, London.
		H. R. Spencer & Co., Geneva, New York.
		W. Wales, New York.
0.18	mm.	Klönne & Müller, Berlin.
0.17	"	E. Leitz, Wetzlar (when tube 160-170 mm.)
0.16-25	"	Ross & Co., London.
0.16	"	Bausch & Lomb Optical Co., Rochester.
0.15-20	"	(16 mm. apochromatic oil-immersions), C. Zeiss, Jena.
0.15-18	"	C. Reichert, Vienna.
0.15	"	Gundlach Optical Co., Rochester.
		W. & H. Seibert, Wetzlar.
		R. & J. Beck, London.
0.12-17	"	J. Zentmayer, Philadelphia.
0.10-125	"	Nachet et Fils, Paris.
		Bezu, Hausser et Cie, Paris.
0.1	"	Swift & Son, London.

A uniform thickness of cover-glass for unadjustable objectives seems also desirable; then by the use of some cover-glass measure, like the one made by Zeiss, the microscopist could select covers of the proper thickness to be used for the specimens to be studied with unadjustable objectives."

Objectives.

["An optical firm offers for sale 'homogeneous' immersion objectives."]

Queen's Micr. Bull., IV. (1887) p. 39.

PELLETAN, J.—Les Objectifs. (Objectives.)

Journ. de Microgr., XI. (1887) pp. 446-8, 476-81 (in part).

ROSS, W. A.—New Optical Substance for Objectives of Microscopes, &c.

["A transparent substance (it is not glass, for no alkali is employed in its manufacture)" having "a hardness and specific gravity equal to that of emerald, whilst its refractive index is obviously very high." And reply by F. H. Wenham that he has "seceded from the ranks of the 'Diatomaniacs,' and ceased to take any interest in dots and striae, and it is not probable that I shall ever again work at the Microscope or its appliances."]

Engl. Mech., XLVI. (1887) pp. 278 and 301.

SCHULZE, A.—On Abbe's Apochromatic Micro-objectives and Compensating Eye-pieces, made of the new optical glasses in the works of Dr. Carl Zeiss in Jena, with some general remarks on object-glasses.

Proc. Phil. Soc. Glasgow, XVIII. (1887) pp. 28-40.

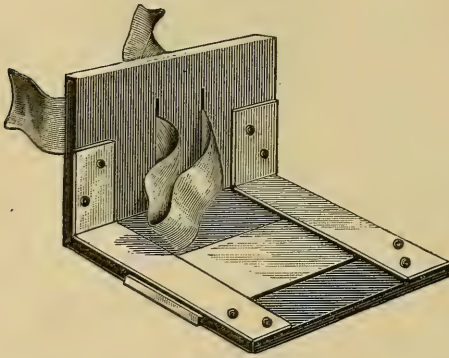
* Cf. *infra*, p. 1029.

(3) Illuminating and other Apparatus.

Borden's Electrical Constant-temperature Apparatus.*—Referring to this apparatus described *ante*, p. 810, Dr. W. C. Borden writes that, owing to some mistake, the latter part of the description of the regulating thermometer was not clear. After describing the regulating thermometer made from a glass tube and small vial, and filled with 95 per cent. alcohol and mercury, which will keep the temperature within one-half a degree, it was intended to say that a simpler one, which will keep the temperature

within two degrees, can be made by simply blowing a bulb on a glass tube and filling the bulb and a portion of the tube with mercury alone.

FIG. 242.



Frog-holder.†—Mr. W. Fearnley describes the frog-holder, fig. 242, which he recommends, as enabling the frog to be placed "in a comfortable position."

It consists of a piece of cardboard 13×8 cm., bent at right angles across its larger axis, the angle being maintained by two copper rectangular straps riveted to the card-

board. A rectangular piece is cut out of the middle of the horizontal half and a glass slip put in between the cardboard and the copper straps. Two slits in the upright half, 1 cm. apart, admit a length (12 cm.) of broad tape. "The frog sits quietly for half an hour at a time upon this contrivance with or without whiffs of chloroform."

Macer's Insect-holder.—This (fig. 243) has been designed by Mr. R. Macer for showing the head, eyes, proboscis, &c., of insects in their living state, with their mode of taking food.

The cones are made of pieces of writing-paper gummed together, and left to dry. Some small discs about $5/16$ in. in diameter are cut, and a hole made in the centre with a No. 3 or 4 saddler's punch. These are blacked and gummed on the cone near to the apex, and, when dry, the apex is cut off level with the disc. With a small stiletto the hole should be made round and smooth. It is necessary to make the holes of different sizes, viz. Nos. 11, 12, 13, 14, 15, and 16 B.W. gauge, to suit the various-sized insects. The disc on the top of the cone is to lay a piece of honey on, to tempt the insect to extend its proboscis in order to show the act of sucking.

FIG. 243.



For catching the fly, glass tubes, $2\frac{1}{2}$ in. long by $1/2$ in. in diameter, with corks to fit, are useful, having a V groove cut in the cork in order to let air into the tube. At the other end of the tube is placed a small plug of cotton-wool. To pass the fly into the cone, hold the tube upright, shake the fly to the bottom (the wool being at the bottom), draw the cork, and place the base of the cone on the tube; then hold the apex of the cone to a bright light, and gently push the plug of wool up

* Amer. Mon. Micr. Journ., viii. (1887) p. 175.

† 'A Course of Elementary Practical Histology,' 1887, pp. 194-5 (1 fig.).

the tube with a pencil, and the fly will soon show its head through the hole in the disc. The tube is then taken away, and the wool plugged up in the cone to keep the fly in its place. A pair of stage forceps, with the ends made hollow like a pair of gasfitter's pliers, can be used to hold the cone.

Mr. Macer showed a living house-fly with this apparatus, at the November *Conversazione*, in a very effective manner.

(4) Photomicrography.

Nelson and Curties's Photomicrographic Camera.—At the November meeting of the Society Mr. E. M. Nelson read the following description of his photomicrographic camera (fig. 244)*:—"Mr. C. L. Curties and myself have designed this camera in the hope of combining efficiency with simplicity. The points in its construction are as follows:—A board on indiarubber feet of sufficient length to take lamp, Microscope, and camera when fully extended. The usual chocks to hold the Microscope feet, and the fine-adjustment focusing-rod on the right-hand side of the board. The camera made of two square † tubes of cardboard sliding one inside the other. Upright wooden ends to hold the cardboard tubes; these slide in grooves in the base board, and are fixed by clamping-screws. The front board has a brass nozzle to fit into the light-excluding cap on the Microscope. The back board is grooved to receive the focusing-glass and the double back. The light-excluding cap is made of cardboard covered with leather, which is as efficient, and not so heavy, as the ordinary brass ones. The double backs are of iron; they are about one-sixth of the cost, and far smoother in their action, than mahogany ones. There is a fitting to hold diaphragms in the back.

The method of working is as follows:—The Microscope, inclined to a horizontal position, is placed in the chocks, the camera closed up, and slid back as far as it will go to the other end of the board. There will now be plenty of room between the camera and the Microscope for the eye to be conveniently placed to the eye-piece. The lamp, condenser, &c., are now centered in the usual manner, and a critical image of the object received by an ordinary eye-piece. When all the necessary adjustments are completed, the ordinary eye-piece is removed, and a projection eye-piece substituted for it. The camera, still closed, is now slid up to the Microscope, leaving sufficient distance between them to allow the hand to focus the eye-lens of the eye-piece. Next let a piece of paper be held up in the position the back will occupy when the photograph is being taken, and the diaphragm of the eye-piece focused, by means of the eye-lens, sharply upon it. The camera is now slid up to the Microscope, and the nozzle inserted in the light-excluding cap. The camera is now extended to the required distance, and the object focused on the plate in the usual manner.

The following are a few hints in the use of the above camera:—It is not advisable to push magnifying power more than ten times the initial power of the objective. To this end the camera has been designed for use with Prof. Abbe's lower-power projection eye-pieces, as he recommends the lower-power eye-pieces in preference to the higher when sufficient camera length can be obtained.

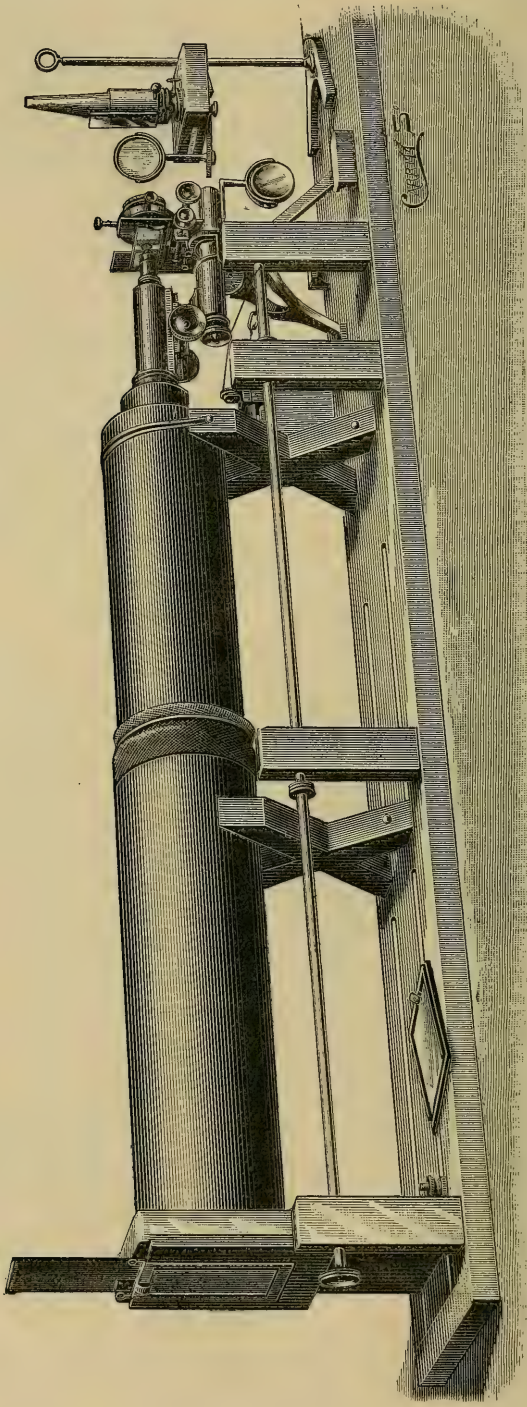
A plain glass screen is recommended in place of the usual ground glass.

The best focusing-lens is an aplanatic lens of six power by Zeiss (Catalogue No. 127).

* Described *ante*, p. 661.

† As shown in the fig. these are round; they were subsequently made square on the suggestion of Mr. J. Mayall, junr., as being more serviceable in that form.

FIG. 244.

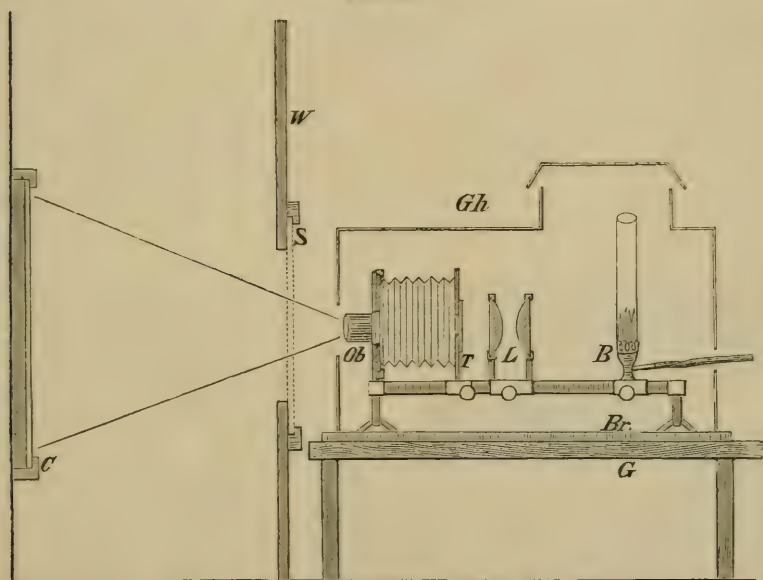


NELSON AND CURTIES'S PHOTOMICROGRAPHIC CAMERA.

To find out the length of exposure, use a Warnerke's sensitometer, in conjunction with the table and directions in Mr. Bousfield's 'Guide to Photomicrography.'"

Photographing Series of Sections.*—Dr. W. His photographs serial sections with a magnification of 10-20 diameters with the following apparatus:—A toothed bar carries at its front end a plate with the photographic objective Ob: a second plate, moved by a rack and provided with a central aperture, serves as object-carrier T: the two plates are united by bellows. The source of light is an Argand burner B, movable along the toothed stage. The light is concentrated by two plano-convex lenses L, with a

FIG 245.



diameter of 11.5 cm. and a focal distance of 8 cm. Diffuse light is avoided by the tin case Gh, in one side of which a broad valve or door is situated, in order to obtain access to the inclosed parts. The objectives used were a Steinheil's *antiplanatic* of 12 cm. focal distance or an *aplanatic* of 14 cm. The latter, though not so powerful as the former, gives a correcter and more definite image. Instead of a camera, the wall of the dark chamber W is used as a reception surface; the latter is divided into two halves and fitted with a door and shutter S. By means of S the light is thrown on or turned off the sensitized paper. The apparatus rests on a board Br which can be moved along the surface of the wooden stand G. This suffices for rough focusing. Finer focusing is obtained by moving the object-carrier T with a screw. Exact focusing is made by turning the objective, which works in a tube provided with a fine screw-thread. The sensitized paper is, if small, fixed down by small pegs; if large it must be fitted into a frame C, fastened to the wall. The image is first focused on a piece of white paper placed behind the glass plate of the frame, and, this done, the sensitized paper is introduced while the shutter S is closed. The paper employed is Eastman's silver bromide paper, which is sensitive enough to artificial light,

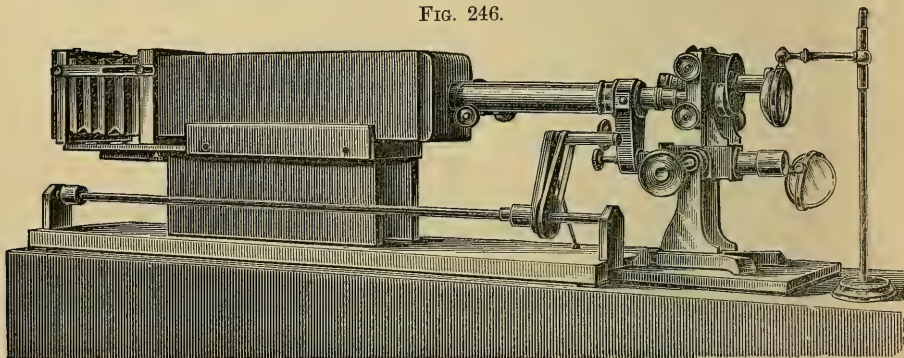
* Arch. f. Anat. u. Physiol.—Anat. Abtheil., 1887, pp. 174-8 1 fig.).

and requires but simple manipulation. The length of exposure varies with magnification and the diaphragm; with Steinheil's aplanatic of 14 cm. focal distance, with diaphragm 4 for a magnification of 10 times, 6–8 minutes are required. Thin sections require longer than thick or deeply stained specimens. All the necessary details of manipulation are given with each packet of the Eastman's paper, but it may be mentioned that after exposure the paper is moistened with water and the image developed with acetate of potash and sulphate of iron. It is then washed in acidulated water, and having been fixed with hyposulphite of soda, is frequently washed, and the sheet is then dried. The time occupied in taking four slides with twenty-five sections each, magnified 10 times, is from an hour to an hour and a quarter.

In addition to giving an accurate copy of the sections, the method is most useful for reconstruction of the image, and if before cutting Kastschenko's definition planes* are applied, the fine lines appear on every negative, and this renders the copies still more suitable and convenient for reconstruction purposes.

Ellis's Focusing Arrangement for Photomicrography.—Mr. John Ellis writes us:—"All the focusing arrangements for photomicrography have appeared so defective to me, that I venture to send a description and drawing of the one I use. The rod running the length of the camera carries

FIG. 246.



a loose arm, at the end of which is a roller, covered with indiarubber, which is made to revolve by an endless strap passing round a wheel upon the rod. The roller is kept in contact with the fine-adjustment screw of the Microscope by an indiarubber band attached to the base-board and the arm."

Nelson's Photomicrographic Focusing-screen.—This (the design of Mr. E. M. Nelson) is made by engraving the English and metrical scales, as well as a crossed diagonal, on the plane-glass plate which is used by nearly all photomicrographers. The engraving, which forms a convenient object to focus on, is a scale for measuring the magnifying power. The English scale is divided into inches, tenths, and half-tenths, and the metrical into cm. and mm. The scales are ruled horizontally, one inch apart, across the plate, one on either side of the cross made by the diagonals. The diagonals are not ruled at the points where they pass through the scales, in order that they may not interfere with the divisions.

DENAEYER, A.—Résumé de la conférence publique sur les procédés de reproduction aux encres grasses des clichés photomicrographiques et des images d'objets scientifiques. Exposé d'un procédé nouveau de photolithographie, avec démonstrations.

* See this Journal, *ante*, p. 511.

pratiques. (Résumé of the public lecture on the processes of reproducing with printing inks photomicrographic clichés and images of scientific objects. Description of a new method of photolithography, with practical demonstrations.)

Bull. Soc. Belg. Micr., XIII. (1887) pp. 182-5 (1 pl.).

HENSEN, V.—Ein photographisches Zimmer für Mikroskopiker. (A photographic room for microscopists.)

Kölliker's Gratulationschrift, 1887, pp. 61-71 (1 pl.).

KING, Y. M.—The Photomicrography of Histological Subjects.

Journ. of Micr., VI. (1887) pp. 205-16, from *New York Med. Journ.*

MARKTANNER, G.—Bemerkungen über Mikrophotographie. (Remarks on photomicrography.)

Phot. Corresp., 1887, p. 237.

(5) Microscopical Optics and Manipulation.

Microscopical Tube-length, its length in millimetres, and the parts included in it by the various opticians of the world.*—Prof. S. H. Gage read a paper with the above title to the Pittsburg Meeting of the American Society of Microscopists.

"In the construction of microscopic objectives, the corrections must be made for the formation of the image at a definite distance, or, in other words, the tube of the stand of the Microscope on which the objective is to be used, must have a definite length. Consequently, the microscopist must know and use this distance or 'microscopical tube-length' to obtain the best results in using the objective in practical work.

In order to obtain the exact distance in millimetres for which objectives are corrected, and the parts of the Microscope included in this distance or 'tube-length,' the following questions were submitted to all the opticians of the world whose addresses could be obtained:—1. For what 'tube-length' do you correct your microscopic objectives? Please give the length in millimetres or inches. 2. Please indicate on the diagram on the opposite page (fig. 247) exactly what parts of the Microscope you include in 'tube-length.' From nearly all precise and satisfactory answers were received, and I wish to express here my appreciation of their courtesy. The answers received are given below, and indicated on the accompanying diagram.

TABLE giving Length in Millimetres and showing parts included in 'Tube-length' by various Opticians.

Parts included in 'Tube-length.' See Diagram.		'Tube-length' in millimetres.
	{ Grunow, New York	203.
<i>a-d</i>	{ Nacet et Fils, Paris	146 or 200.
	{ Powell and Lealand, London	254.
	{ C. Reichert, Vienna	160-180.
<i>a-d</i>	{ W. Wales, New York	254.
	{ Bausch & Lomb Optical Co., Rochester	216.
	{ Bézu, Haussier et Cie., Paris	220.
	{ Klönne and Müller, Berlin	160-180 or 254.
<i>b-d</i>	{ W. & H. Seibert, Wetzlar	190.
	{ Swift & Son, London	165 to 228½.
	{ C. Zeiss, Jena	160 or 250.
<i>a-g</i>	{ Gundlach Optical Co., Rochester ..	254.
<i>c-d</i>	{ Ross & Co., London	254.
<i>e-e</i>	{ R. & J. Beck, London	254.
<i>c-g</i>	{ H. R. Spencer & Co., Geneva, N.Y. ..	254.
<i>e-f</i>	{ J. Green, Brooklyn	254.
<i>e'-e</i>	{ E. Leitz, Wetzlar	125-180.
	{ For Oil-immersions	160.

* Microscope, vii. (1887) pp. 289-92 (1 fig.).

A glance at the table and diagram is sufficient to show that there is about as great diversity as possible in the parts included in 'tube-length,' and that the length in millimetres, including these parts, is likewise very diverse. This has, doubtless, come about simply because there was no general standard, and each optician selected for himself a standard. For

FIG. 247.

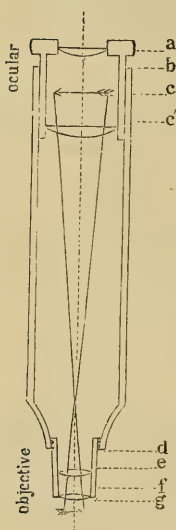


Diagram showing the parts of the Microscope included in 'Tube-length' by various opticians of the world. (See table above.)

the sake of those who use the Microscope, it is hoped that a uniform standard may be chosen, or that, at most, but two standards should be decided on by all opticians. These two lengths in millimetres would probably best be 254 mm. for a long or English 'tube-length,' and 160 mm. for the short or Continental 'tube-length.' Furthermore, the same parts of the Microscope should be included in the 'tube-length,' and the parts included should be readily determinable by the youngest student. The parts included by six of the opticians named above, viz.: from the top of the tube (b) where the ocular is inserted, to the lower end (d) where the objective is screwed in, answer this requirement of simplicity. Without urging this as the best possible selection, it will readily be seen that this 'tube-length' may be easily measured where the ocular and objective are not in position, and that makers of stands who do not also make objectives could easily make the tubes of their Microscopes of exactly the right length for the objectives of all objective-makers. While it is true that the objectives of various makers are in mountings of different lengths, and therefore, other things being equal, tend to increase or diminish the actual or optical 'tube-length,' and thus to vary the magnification of the Microscope, if each maker would choose the length designated above (b-d) for which to correct his objectives in their mountings, then no matter how long or short that mounting might be, the microscopist would be able to measure off the

right length on the tube of his Microscope, for which the objective was corrected, and having this length once determined, it would not need to be changed when an objective of different length of setting was used.

Furthermore, the convenience of the microscopist and uniformity in 'tube-length' would be both subserved if the eye-pieces or oculars were made '*parfocal*,'* that is, the settings be so adjusted that the lower focal points of all the eye-pieces shall be at the same level when in position in the tube of the Microscope, then no refocusing of the Microscope would be necessary upon changing oculars. If also the level of the 'lower focal points' of the different oculars were made to fall at the level of the top of the body-tube of the Microscope, one end of the so-called 'optical tube-length' would be always determinable, and correspond with one end, that is the upper end, of the tube of the Microscope.

So long as no common standard is employed, it seems to the writer that every objective should be accompanied by a statement and a diagram indicating the tube-length in millimetres for which it was corrected, and showing also the parts of the Microscope included in this measurement.

* See this Journal, 1886, p. 1050.

If the objective is unadjustable, a statement should also accompany it, giving the thickness of cover-glass for which it was adjusted."

On this paper the editor of 'The Microscope' * writes as follows:—

"Every microscopist will thank Prof. S. H. Gage for publicly calling attention, in his article, read at the recent meeting of the American Society of Microscopists, to the remarkable lack of uniformity which exists among opticians in their standards of tube-length and in the parts which they include in their computation of it.

All who seek and desire accuracy in their objectives, understand that they are corrected for a definite tube-length, and that perfect performance is possible only when that tube-length is used. The lack of knowledge, even among expert microscopists, of the exact length for which given objectives are corrected, and the difficulty of measuring it from the hidden points adopted by many makers, have led them frequently to disregard the perfect accuracy which they should observe in adjusting their Microscopes, and to be satisfied with an approximation to the proper tube-length. Text-books and makers' catalogues, also, are almost silent in the matter, and microscopists who use the Microscope in their every-day business, but who give but little attention to the optical principles of its construction and working, have remained in ignorance of any necessity for such an adjustment. Prof. Gage's article, with its complete tables, brings the subject forcibly to the mind of every microscopist, and makes clear the necessity of the adoption by makers of a uniform tube-length, and of uniform and easily accessible points between which to compute it.

Prof. Gage, in his remarks, rather hesitated to ask opticians to change their various standards to a common one. From conversations with several opticians we have learned that there are no serious objections to such a change, and we urge upon manufacturers that it be made. The committee appointed by the American Society of Microscopists to investigate the subject and report at the next meeting, may, if their judgment agree with ours, accomplish much to this end.

A tube-length of 254 mm. is generally spoken of as the standard, and is adopted by the majority of opticians, and this, we believe, should be the only one chosen.

In determining the parts to be included in the measurement of tube-length there is more opportunity for diverse views. The most scientific measurement probably, would be between the optical centre of the objective and the optical centre of the ocular. These points are, however, the most difficult to determine, and they vary with each objective and each eye-piece. The same objections hold good with any measurement which has for its lower extremity any part of the objective. Uniformity in the length of the setting, and the position of the lenses of objectives, is practically impossible. The lower extremity of the tube (*d* in Prof. Gage's figure) is the only lower fixed point, and is the point selected by all but a very few opticians.

For the upper point *c* and *c'* can be excluded, *a* and *b* being the only points that are fixed and accessible, and the majority of opticians include the parts between one of these points and *d* in their measurement of tube-length. These points can be determined by the youngest student, and variations in objectives will not affect the length. Prof. Gage prefers the measurement *b* to *d*. This is, perhaps, the simplest, but is open to the objection that different opticians use eye-pieces of different construction. European makers use the Continental pattern, in which the eye-lens is but 1 or 2 mm. above the body, while Americans prefer the eye-piece with

* Microscope, vii. (1887) pp. 305-6.

neck, which brings the eye-lens 12 to 15 mm. above the body. This, of course, increases the optical tube-length just so much, and it would be necessary for opticians to indicate on the objective whether it was corrected for the Continental or the American ocular. With the measurement a to d each microscopist could easily adapt his tube-length to suit either style of ocular.

We can join Prof. Gage also in his plea for 'par-focal' oculars. Their adoption would be another step in the development of a uniformity in apparatus, which is of so great convenience to busy workers, and which tends so much to harmonize the work of various manufacturers.

We believe that these subjects, so tersely brought forward by Prof. Gage, should be agitated until manufacturers adopt them; and to further this end we shall be glad to publish correspondence from all interested opticians and microscopists."

Measurement of Power.*—Mr. E. M. Nelson says that it is sometimes useful to know the "initial" magnifying power of an objective, by "initial" power meaning the size to which an image will be magnified by an objective alone when projected on a screen at a distance of 10 in.

In practically measuring this power, it will be found a more accurate plan to increase the distance to, say, 60 in., and divide the result by 6. These measurements are very easily performed when one has a camera, but it is not so easy to do them without. Therefore, another and somewhat loose way of getting at the initial power is adopted, viz. as follows:—Measure the combined magnifying power of the objective, and say 2 in., or A, eye-piece, and divide the result by 5. This method would do very well if the exact multiplying power of the eye-piece was 5, and if the length of the body remained constant. As it is not an easy matter to find out the exact multiplying power of an eye-piece, Mr. Nelson recommends any one desirous of knowing this to measure or get measured the initial power of one of his objectives; then measure the combined power of this lens and his eye-piece, paying great attention to his tube-length during the operation. This will give him once for all the multiplying power of his eye-piece with that tube-length. He will then be in a position to ascertain the initial power of any other lens with that eye-piece and the same tube-length. But as the optical tube-length may differ from the actual tube-length, and does differ to a certain extent, with objectives of ordinary construction, this process is not so simple as it appears. In order to get fairly accurate results with the higher powers, a certain percentage must be deducted. To give some examples:

Thus, 1 in. at 60 in. increases the image of $\cdot 01$ in. to $\cdot 66$ in., its power, therefore, is 66, which at 10 in. = 11 = initial power. The combined power of this lens with an A eye-piece is 55, which gives 5 as the multiplying power of the eye-piece. Now, if the combined power of this eye-piece with a $2/3 = 75$ we may assume the initial power of the $2/3$ is 15.

If, however, we treat higher powers in the same way, we shall get too high values. Thus the combined power of a $1/4$ and the eye-piece is 203; dividing by 5 we get 40.6 as the initial power, whereas 39.3 is the real power.

Again, the combined power of a certain $1/12$ and the eye-piece is 600, which, divided by 5, gives 120 as its initial power, whereas it is in reality 113.2. The empirical rule Mr. Nelson employs is to deduct 2 per cent. for $1/2$, 3 per cent. for $1/4$, 4 per cent. for $1/6$, 6 per cent. for $1/8$, $1/12$,

* Eng. Mech., xlv. (1887) pp. 188-9.

&c. Thus taking the $\frac{1}{4}$ above and deducting 3 per cent. from the 203, we get 197, which, divided by 5, gives 39.4, a result very near the truth.

A certain $\frac{1}{8}$ gives a combined power of 450, deduct 6 per cent. = 423, divide by 5 = 84.6, the actual being 85. For short bodies of $6\frac{1}{2}$ in., or Continental size, a different percentage must be employed. The following gives fair results:—2 per cent. for $\frac{1}{2}$, 4 per cent. for $\frac{1}{4}$, 6 per cent. for $\frac{1}{6}$, 8 per cent. for $\frac{1}{8}$, and 10 per cent. for $\frac{1}{12}$.

Method of Intensifying the Resolving Power of Microscope Objectives.*—Mr. G. D. Hirst describes a simple way of vastly improving the definition of objectives on close-lined test objects, which has lately come under his notice. The credit of the discovery is due to Mr. Francis, of Sydney.

Take a valve of, say, *Amphipleura pellucida*, and, having got the best results obtainable with mirror and condenser, let the analysing prism belonging to the polarizing apparatus be placed over the eye-piece, and rotated until it darkens the field, which it will do, though not to the same extent as when used with the polarizing prism. On carefully focusing the diatom, the lines will show themselves with an extraordinary increase of definition. Valves that without the aid of the prism only show a washy sort of resolution, will now show the lines as black as the bars of a gridiron.

On *P. angulatum* by central light the result is also splendid. The same effect can also be obtained, though perhaps to a slightly inferior degree, with the objective, or, as it is placed in some stands, in a sliding box in the body of the Microscope; in the latter case, as it cannot be rotated, the valve of *A. pellucida* should lie horizontally. For general purposes, it is better for the prism to fit over the eye-piece, as besides giving better definition in that position, with a diatom like *P. angulatum* and prism over the objective, the diffraction spectra would be cut out of the top and bottom of the back lens and the effect spoiled. Of course, in the case of *A. pellucida*, with the valve lying horizontally, it does not matter, as the dioptric ray and single spectrum are not cut off in any way by the prism or the box in which it is set. The prism has the effect of greatly diminishing the light of the dioptric beam; at the same time it scarcely touches that transmitted by the diffraction spectra.

The application of the prism will not of course make an objective resolve a test beyond the reach of its aperture; but it often happens that in the case of close-lined objects we can see the spectrum at the back of the objective when the lines cannot be seen in the object itself. It is then that the prism shows its power, as its use will at once bring out the lines with the greatest ease and sharpness.

Mr. E. M. Nelson† found, while investigating the matter, that the diffraction spectrum of *A. pellucida* (illuminated by oblique beam from oil-imm. achromatic condenser, and with a water-imm. $\frac{1}{12}$) showed all the green, but no red. On examining the spectrum through the analysing prism without an eye-piece he found that when the prism was in a line with the dioptric beam and the diffraction spectrum, the brightness of the green was intensified. On replacing the eye-piece, and viewing the image through the prism used above the eye-piece, as directed by Mr. Hirst, there could be no doubt that the transverse striæ were much sharper and blacker than when viewed without the prism. The prism must, of course, be kept in a line with the dioptric beam and the diffraction spectra. Should the prism be turned across, even if it does not cut off aperture, the definition will be impaired.

* Eng. Mech., xlv. (1887) p. 232.

† Ibid., p. 254.

He next changed the water-imm. 1/12 for a water-imm. 1/16 of less angle, which would barely resolve the *A. pellucida*—that is to say, would only resolve it in patches, and not from end to end. On examining this with the prism, he found that the parts which were unresolved were still unresolved; but those parts which were resolved were intensified.

“The image of *A. pellucida* with an apochromatic 1/8 (1.4 N.A.), my new eye-piece, and the prism is something very fine, such as I have never seen before.”

He also tried the prism with several very subtle direct light tests, but cannot say that he found any improvement in the image. On the whole, he should think this class of objects would be seen better without the prism. Probably the efficacy of the prism, when used with a lined test, lies in the fact that it intensifies the diffraction spectra when it is placed in a certain direction to it.

BROKENSHIRE, F. R.—Measurement of Magnifying Power of Micro-objectives.

[Complaint that the subject has not received the elucidation he anticipated.]

Engl. Mech., XLVI. (1887) p. 300.

DIDELOT, L.—Du pouvoir amplifiant du Microscope, détermination théorique et expérimentale: suivi d'une table à quatre décimales, des inverses de 1000 premiers nombres de 0.01 à 10.00. (The magnifying power of the Microscope. Theoretical and experimental determination: followed by a table to four places of decimals of the reciprocals of 1000 prime numbers from 0.01 to 10.00.)

2nd ed., 90 pp., 2 pls., 8vo, Paris, 1887.

GABRIEL.—Quelques généralités sur les instruments d'optique. (Some general considerations on optical instruments.)

Arch. Sci. Phys. et Nat., XVIII. (1887) pp. 339–41.

HODGKINSON, A.—On the Diffraction of Microscopic Objects in Relation to the Resolving Power of Objectives. *Proc. Manch. Lit. and Phil. Soc.*, XXV. (1886) p. 263.

(6) Miscellaneous.

“The Microscope as a factor in the establishment of a constant of nature.”—The following is the first part of the Presidential Address delivered by Prof. W. A. Rogers before the American Society of Microscopists at the Pittsburgh Annual Meeting:—

“Microscopy is a cosmopolitan science. We may go farther than this, and say that microscopy is more nearly cosmopolitan in its character than any other science. If I did not believe this to be true I should not have consented to occupy the honourable position which I now hold by your suffrages, for there are many members of this Society to whom the honour more justly belongs by virtue of greater familiarity with the technics of our science. I suppose that I am indebted to this expression of your confidence on account of the use which I have made of the Microscope as an essential factor in a single line of research.

It is the glory of our science that the Microscope supplements the natural vision to such an extent that we can submit nearly every theory, nearly every deduction from experiment, nearly every fact of observation, to the supreme and only test by which a real truth in nature can be established, viz. through the medium of one of the senses with which we have been endowed by the Creator. It has been said that microscopy has no claim to be regarded as a science, and that the Microscope is simply an instrumental agent occupying with respect to other sciences a position similar to that which the telescope sustains in its relation to astronomy. A convincing answer to this criticism is found in the fact that the telescope is limited in its application to a comparatively narrow field of research. Where the telescope answers a single question the Microscope answers a

* Microscope, vii. (1887) pp. 257–61. Corrected by Prof. Rogers.

thousand. Spectroscopy has become a recognized science, not so much because of its revelations in regard to the nature of light, as on account of the application of the spectroscope as an instrument to the study of the physical properties of matter and of motion not only on the earth, but in worlds other than our own.

In discussing the question whether microscopy can be regarded as a science, we must always bear in mind the fact that a science is only a convenient name for a group of similar laws of nature, and that the term is properly applicable not only to the development of these laws, but to their application to the useful economies of life. Thus we have the science of engineering, in which mathematical analysis is as much an essential part as skill in mechanical construction. But this analysis would serve no useful purpose if did not rest ultimately on facts of observation.

The limitations which necessarily belong to a definition of physical science are clearly expressed by Tate in his most admirable treatise on Heat. He says: 'Nothing can be learned as to the physical world save by observation and experiment, or by mathematical deductions from data so obtained.' Now the Microscope as an instrument of research stands unrivalled, not only in respect to the precision of the observations made with its aid, but also in the universality of its application in furnishing what Tate calls 'the data so obtained.'

Each succeeding year witnesses an extension of the range of its applications. Within a few years, while retaining its claim as an essential factor in scientific research, it has also become a very material aid in many mechanical industries. It is a common impression that the Microscope is too delicate an instrument to be used in the ordinary operations of mechanical construction, and that the apparent necessity of using transmitted light for the purpose of illumination is an absolute barrier to any extended employment of the instrument. The latter difficulty is entirely obviated by the use of the opaque illuminator invented by Tolles, by which a bright metal surface can be examined with the utmost ease, while actual experience has shown that it is by no means necessary that the instrument should be mounted upon massive piers insulated from surrounding objects.

I cannot more forcibly combat this impression than by referring to two cases within my own experience. The 'Proceedings' of the Society of Mechanical Engineers for 1884 contains a description of a method of cutting a screw in which each thread is made to correspond in pitch with equal subdivisions of a standard yard traced upon a metal bar. The screw for the engine constructed for Cornell University was made in this manner. Prof. Anthony has shown that the maximum accumulated error of the screw does not reach 2 mikrons for a limit of 20 inches, while the actual error at any selected point will not reach 1 mikron. This screw was cut in the manner indicated, in the third storey of a building occupied by machinery, which produced a decided tremor in every room. It was only found necessary to make the attachment of the Microscope to the compound rest of the lathe very firm, and to brace the bed of the lathe very securely from the floor.

The writer was recently called upon to 'level up' the bed of a very heavy planer, having ways 18 ft. in length. Several days had already been spent in securing as good an adjustment as could be obtained with the aid of a spirit-level of special construction. A plank 22 ft. in length, 8 in. in width, and 2 in. in thickness was set up edgewise beside the platen of the planer, but insulated from it. A groove $1\frac{1}{2}$ in. wide and $1\frac{1}{2}$ in. deep was ploughed in the upper face of the plank, and after having stopped both ends, the groove was filled with mercury. The surface of the mercury then

formed an invariable plane of reference. The Microscope was securely attached to the platen and adjusted for sharp focus upon the surface of the mercury at one end. The platen was then moved along until the Microscope occupied a position near the other end of the groove. This end was then adjusted by elevation or depression as required, until the surface of the mercury was sharply in focus. After two trials it was found that the surface of the mercury was at the same constant focal distance from the Microscope as indicated by the sharpness of definition. Notwithstanding the fact that extreme care had been taken in the original adjustment by the aid of the spirit-level, it was found that as the platen moved towards the central part of the bed the focus became more and more indistinct, indicating that the central part was too low. The proper elevation was then made at these points by means of heavy set-screws, when it was found that the mercury was sharply in focus under the objective throughout the entire range of motion. As a check upon the accuracy of the adjustment a surface-plate 8 ft. in length was now planed, when it was found that the deviation from a true surface did not at any point exceed the third part of the thickness of tissue paper. Two facts of considerable importance are to be noticed in connection with this experiment. First, that the time occupied for the complete adjustment was only twenty-five minutes; and, second, that during the entire operation the machinery of the shop was running at half-speed.

These and similar observations have led the writer to advocate a more extended use of the Microscope in the every-day work of the machine shop. By attaching the Microscope firmly to the slide-rest of the lathe, the ordinary operations of turning shoulders to a given length, and of cylinders to a given diameter, can be more expeditiously, more exactly, more economically performed than by the usual method.

It is freely admitted by mechanics that a decided advance in mechanical construction would be made by the employment of uniform measures of length. This can be easily and profitably accomplished in any well regulated shop, employing as many as fifty hands, by delivering from a standards room any desired unit of length, in the same way that tools are delivered from a tool-room. The expense of a comparator, from which any measure of length could be obtained within a limit of time which would not ordinarily exceed one minute, would not be great. If this comparator were placed in charge of a person familiar with its use, and in a convenient location, any workman could have a calliper set for him in half the time that would be required in setting it to a scale by the usual method; the precision would be incomparably greater, and absolute uniformity would be secured in every dimension of length employed. The various points to which I have briefly called attention are to be considered simply as illustrations of the many ways in which the useful service of the Microscope may be extended.

In the address which I am called upon to make this evening, as President of the American Society of Microscopists, I have selected a single application of the Microscope in scientific research. *I beg to call your attention to the Microscope as a factor in the establishment of a constant of nature.*

If a bar of metal, which has the faces of each end parallel and at right angles to its axis, is submerged in melting ice, the perpendicular distance between the two faces may be said to represent a definite unit of length at the temperature of 32° F. or of 0° C. If this distance is identical in length under similar conditions with a certain bar of platinum now deposited at the International Bureau of Weights and Measures at Breteuil

near Paris, and designated the '*Mètre des Archives*,' the length of the bar is said to be one metre. If now the bar is submerged in a liquid which has throughout its entire mass a temperature one degree higher than that of melting ice, its length, after it has reached the same temperature as the liquid, will be increased by a certain fraction of its entire length. If this length is subdivided into one million equal parts, and if the increase is, for example, ten parts in one million, the coefficient of expansion of the metal is said to be ten mikrons. If the increase in length proceeds uniformly for each and for every increment of temperature, we can say, for example, that the length of the bar at 100° C. will be 1000 mikrons, or one millimetre greater than it was at 0° C. We can also say that if the temperature of the entire mass of metal is again reduced to 0° the length of the bar will be exactly the same as it was before the increase of temperature took place.

There is some evidence that when certain metals are exposed to very violent changes in temperature, as when zinc is removed from a temperature of 100° C. and is submerged in melting ice, the molecular arrangement of the metal is disturbed to such an extent that the return to its original condition may be delayed for several days, and even for several weeks; but it cannot, at the present time, be positively asserted that the return will not ultimately take place.

It will be noticed that the definition of the coefficient of expansion which has been given, viz. the increase in length due to an increase of temperature from 0° to 1° , contains the important limitation that the entire mass of the metal shall have reached the temperature of 0° .

We have no report of the remaining part of the address, except the following abstract of the '*Pittsburg Dispatch*,' which gave an account of the proceedings of the meeting:—

"Prof. Rogers chose as his subject, 'A demonstration of the fact that metals may be safely employed to measure temperature by means of their expansion under an increase of temperature.' He began with a defence of microscopy as a science, and gave a brief review of the various ways in which the usefulness of the Microscope may be extended, especially in the direction of mechanical constructions. He then proceeded to discuss the Microscope as a factor in the determination of a constant of nature, which was practically the real subject of his address. In general the problem to be considered is, 'Do metals expand uniformly under every variation of temperature?' After limiting the definition of the term 'constant of nature,' to the three bars of metal investigated, viz. a bar of Baily's metal, composed of 16 parts copper, $2\frac{1}{2}$ parts tin, and 1 part zinc; a bar of Jessup's steel and a bar of glass made by Chance & Sons in 1870 for the British Board of Trade, he gave an account of the various kinds of errors to which observations of this class are liable. Incidentally he referred to the different kinds of thermometers in use, and the manner in which they are constructed, relating many interesting experiments showing the real value of their indications, and how they sometimes fail to register correctly on account of atmospheric changes and conditions. After describing the methods employed to detect the errors of the thermometers employed to measure the temperature at which these three standards of length were compared, he gave an account of the investigation by which he determined that the relative coefficients of expansion of these metals are constant for all temperatures between -5° and 95° temperature. He made 293 sets of observations, nearly all of them about half an hour after sunrise on clear days, and a little later on cloudy days. The time at which the comparisons between the lengths of these standards were made, was defined by

the speaker to be the critical point of no variation of temperature when there was an equilibrium between the temperature of the bars of metal, of the surrounding air, and of the thermometer employed. As a result of observations extending from December, 1886, to July, 1887, the conclusion was reached, first: 'That the relative coefficients of expansion of these metals are really constant for ordinary temperatures; and second, that the values of the absolute coefficients have not changed since 1881.'*"

Fasoldt's Rulings.†—Mr. C. Fasoldt writes as follows:—"A gentleman interested in microscopy lately called my attention to an item in the report of the Microscopical Society of Washington, D.C., in the April number of the 'American Monthly Microscopical Journal,' p. 77: 'Dr. Schaeffer asked if any of the Society had seen Fasoldt's ruling on glass. Prof. Seaman said Fasoldt had done some fine work, but the finest was that done by Prof. Rogers,' &c.

I was not aware that I was recognized as an amateur in mechanics, and that I imposed on the world with inferior products; neither has a commission of any exhibition ever rendered such a verdict. Contrary to that, in World, International, and State Exhibitions I was always recognized as master of the masters, which is shown by the following first-class awards:—

Prize Medal of Honour and Diploma of Merit awarded at the Centennial Exposition of 1876. Also First Prize Medal and Diploma, International Industrial Exhibition, Buffalo, N.Y. Three First Prize Medals, Utica Mechanics' Association. First Premium Medal, Syracuse Mechanics' Association. Silver Medal and Certificate of Highest Merit of New York State.

Regarding the sentence that I do not publish my method of ruling, I do not want to dictate to other persons what methods to use to accomplish a certain work—in somewhat by showing and illustrating my machine—neither do I want to contradict those who attempt to illustrate how work is and should be done. I claim that everybody has the privilege to construct and make their own Microscope, measuring and illuminating apparatus, ruling machine, and machinery to make those and all other devices that anybody wished to make for private or general public use, as I have done.

As it is proper for a man to uphold and prove what he has said, or either retract such quotation, I would ask Prof. Seaman to send the following rulings made by Prof. Rogers. All test-plates should be ruled in bands, beginning with and running up every 10,000 to the denomination as given below.

- | | |
|---|--|
| 1 | plate ruled up to 200,000, or 250,000 lines per inch |
| 1 | " " " " 120,000 " |
| 1 | " " " " 6,000 " |
| 3 | stage mic. ruled 1, 10, 100, 1000 per inch. |
| 3 | stage mic. ruled 100, 1000, 5000, 10,000 lines per inch. |

When I will appoint a committee of four to measure and resolve them. And the Professor can appoint his committee and do likewise with my rulings.

We have numerous times resolved 200,000 and over. I have the facilities to do it with, and measuring likewise."

* Cf. Amer. Mon. Micr. Journ., viii. (1887) pp. 196-7, for a criticism on this address, so far as it defends the claim of microscopy to the title of a science. "We see no advantage to be gained by naming a science which does not exist. In a truly scientific sense there is no such thing as a science of microscopy as defined by Prof. Rogers."

† Amer. Mon. Micr. Journ., viii. (1887) pp. 175-6.

It would be very interesting if Mr. Fasoldt would tell us how he resolves the "numerous lines, 200,000 and over." Until he does this his claim to be recognized as a "master of the masters" cannot be admitted.

Nägeli and Schwendener's 'The Microscope in Theory and Practice.'*—This translation of Prof. Nägeli and Schwendener's well-known treatise on the Microscope is at last published, after suffering almost unprecedented vicissitudes. In addition to disasters to the manuscript, the whole book, after being printed off, was burnt in 1884, in a great fire in the City in which the printer's works were involved. Those responsible for the publication were so far discouraged that they practically abandoned the matter, and it is due to the enterprise of the publishers that the translation is after all given to the English-speaking public. Although advances have been made since the book was written in several directions, notably by Professor Abbe, Nägeli and Schwendener's work will always be a classical landmark in the history of the Microscope, and will be more especially valuable to English microscopists as the first book in their language to deal with the Microscope on a scientific basis unadulterated on one side by descriptions of the various forms of Microscopes and microscopical apparatus, or on the other by a review of the microscopical subjects of the Animal, Vegetable, and Mineral Kingdoms. As such we may commend the book to a place in every microscopical library.

The following is extracted from the preface:—

"This translation of Nägeli and Schwendener's well-known treatise 'Das Mikroskop' was commenced by Mr. Frank Crisp, Secretary of the Royal Microscopical Society, immediately after the publication of the last (German) edition (1877), with the intention—as indicated by him in a communication to the Quekett Microscopical Club—of filling up a blank in English microscopical literature in regard to the scientific technical treatment of the theory of the Microscope, in which English text-books were so deficient.

The student refers in vain, even at the present date, to English works on the Microscope for explanations of the theory of the construction of objectives, eye-pieces, &c., or for the discussion of the phenomena of diffraction and polarization in their connection with the Microscope, or for any scientific treatment of the question of interpreting microscopical images or the theory of microscopic observation. These subjects are dealt with systematically in German works only, and notably in that of Nägeli and Schwendener.

The translation was thus undertaken with a view to placing before English readers the then best known collective exposition or technical treatment of these points by German writers.

When the rough draft of the translation was completed, the first five sheets (80 pp.), were revised and put in type, but in consequence of prior claims upon his time in connection with the Royal Microscopical Society, Mr. Crisp was compelled to relinquish the task of further revision, and of passing the volume through the press, a labour which was undertaken by Mr. John Mayall, jun., one of the editors of the Society's Journal.

Just as the printing was completed, a fire destroyed the premises of the printers, and the whole of the printed sheets of the volume were burnt, except one set as far as p. 374, which the publishers had retained in their possession, together with a few of the woodcuts.

* Nägeli, C., and Schwendener, S., 'The Microscope in Theory and Practice' (translated from the German), xi. and 382 pp. and 210 figs. (Svo, Swan Sonnenschein, Lowrey & Co., London, 1887).

Under these circumstances the publishers had to consider the alternatives (1) of abandoning the issue of the volume; or (2) of incurring the additional expense of re-translating the portion of the work totally lost by the fire, replacing the missing woodcuts, and reprinting the whole; or (3) of reprinting as far as p. 374 only, omitting therefore Part VIII. (Microphysics), Part IX. (Microchemistry), and Part X. (Morphology). It was finally decided to adopt the last course, hence the present issue.

Whilst it is much to be regretted that this translation should only now be issued, microscopists will no doubt appreciate the advantage of having a version in English of a work which has received high commendation from both English and foreign critics; and it is hoped that this volume may be supplemented before long by an English version of the further researches in microscopical optics by Professor E. Abbe, of Jena, which have extended so much our knowledge of the matters dealt with in Nägeli and Schwen- dener's work."

Death of Mr. T. Bolton.—We much regret to have to chronicle the death of Mr. T. Bolton, a Fellow of the Society. Mr. Bolton's intense devotion to microscopical matters is well known to all microscopists, and the perseverance with which he carried on his supply of microscopical organisms was beyond all praise. His services in this connection had materially added to our knowledge of the fresh-water and other fauna of this country, and he was the discoverer of forms not only new to England but new to science. He was ever ready to assist microscopists and naturalists to the utmost of the means at his command, without, as we have often found, making any sufficiently adequate pecuniary demand in return. His death is a serious loss to microscopy.

In 1884 the Council of the Royal Society placed 50*l.* in the hands of Prof. Ray Lankester for the purpose of employing Mr. Bolton to collect material for an investigation of the fresh-water fauna of the midland counties; and at the Fisheries Exhibition a gold medal was awarded to him for an exhibition of minute life relating to the food of fishes. It will be remembered that last year, in response to a memorial signed by many eminent men of science, a Civil List pension of 50*l.* per annum was granted to him.

"A QUEKETT CLUBMAN."—*The Student's Handbook to the Microscope: A Practical Guide to its Selection and Management.* 72 pp. and figs., 8vo, London, 1887.

ALESSANDRI, P. E.—*Il Microscopio e sua applicazione alla Merceologia e Bromatologia.* 173 pp. and 230 figs., 8vo, Milano, 1886.

American Society of Microscopists.—Pittsburg Meeting.

St. Louis Med. and Surg. Journ., LIII (1887) pp. 229-34.

BREZINA, A.—*Das neue Goniometer der K.K. Geologischen Reichsanstalt.* (The new goniometer of the I.R. Geological Reichsanstalt.)

[The optical part is thus described:—"The observing telescope is provided with a Huyghenian eye-piece, which can be moved to or from the objective, so that by inserting a lens in front of the objective the observer is able to use the whole system of lenses as a Microscope, and by approaching the eye-piece towards the objective to convert it into a telescope. In this way the connection between the image of the signal and that of the face may be tested in crystals with numerous faces. Since, however, the telescope may be raised or lowered, by which movements its distance from the axis of the circle is changed, the lens must also be capable of movement towards or from the axis. For this purpose the lens-holder is made to slide upon the telescope tube."]

Jahrb. Geol. Reichsanst., XXXIV. (1884) pp. 321-34.

Abstr. in *Neues Jahrb. f. Mineral.*, II. (1887) pp. 239-40.

[COPE, E. D., and KINGSLEY, J. S.]—**Wanted a Definition of a "Philosophical Instrument."**

[Complaint that with the U.S. Custom officials a hydrometer is a "philosophical instrument," while a thermometer is a "manufacture of glass," paying a higher

duty, while "Microscopes and microtomes are 'manufactures of metal,' as ruled by the Washington wiseacres in opposition to the opinions of the best scientific men of the country. . . . A more reasonable interpretation of existing laws, or better, a revision and a reduction of the present duties, would tend generally towards the advancement of American science and the promotion of American honesty."]

Amer. Natural., XXI. (1887) p. 922.

CUTTER, E.—[The Microscope and Old Age.]

"I hope that the Microscope may not be relegated to the younger members of our profession alone. It is an instrument for old age. Ehrenberg worked with his Microscope up to within a few days of his death. The focusing accommodates the defects of vision. Moreover, it is a comfort and solace to an aged physician to quietly explore the mysteries of the unseen world he has been dealing with microscopically during a long and laborious life. May it be a good preparation for that endless life where we shall no longer see through a glass darkly."]

Microscope, VII. (1887) p. 284.

GORECKI.—Du Microscope appliqué à l'étude de la Minéralogie et de la Pétrographie. Minéralogie micrographique. (The Microscope applied to the study of mineralogy and petrography. Microscopical mineralogy.) 8vo, Paris, 1887.

Microscopical Studies, Pursuit of, by Amateurs.

[Discussion of the question "How can a man who uses the Microscope, and studies pursued by its aid as a means of recreation, retain his interest in the subject?"]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 197-8.

Microscopy in Calcutta.

Sci.-Gossip, 1887, p. 229-30.

NEUMANN, C.—Die Brillen, das dioptrische Fernrohr und Mikroskop. Ein Handbuch für praktische Optiker. (Spectacles, the dioptric telescope and Microscope. A handbook for practical opticians.)

xxxii. and 232 pp., 95 figs., 8vo, Wien, Pest, Leipzig, 1887.

[OSBORN, H. L.]—Microscope in Medicine.

Amer. Mon. Micr. Journ., VIII. (1887) pp. 155-6.

ROYSTON-PIGOTT, G. W.—Microscopical Advances. XXV., XXVI., XXVII., XXVIII.

[Butterfly dust; villi and beads; its isolated beading and reticulations; reticulations and crossbars; ultimate beading and woof.]

Engl. Mech., XLVI. (1887) pp. 101-2, 173-4, 245-6, 291-2 (4, 10, 5, and 8 figs.).

VERLOT, B.—Le Guide du Botaniste herborisant. (Guide for the collecting botanist.)

[Contains descriptions of Microscopes, &c.]

3rd ed. with introduction by Naudin, xvi. and 776 pp. and 34 figs., 12mo, Paris, 1886.

'B. Technique.*

(1) Collecting Objects, including Culture Processes.

Cultivation of *Chætomium*.† — For the cultivation of *Chætomium Kunzeanum*, says Dr. F. Oltmanns, plum decoction is more suitable than that of dung, as bacteria develop in it less easily. In order to determine whether the formation of a pollinodium ceases in the ascogonium, the examination of a dead cultivation does not suffice; recourse must be had to cultivations which allow continual observation of a particular carpogonium. Cultivations in moist chambers in hanging drops as they are usually carried out are impracticable, for the fungus stands in need of much oxygen. The mycelia are rarely brought to the fructification, for before this occurs a cessation of their general growth takes place, and even if the perithecia are actually formed it is not of much use, as these prefer to arise from mycelia projecting into the air, or are as near the culture-drops and air as possible — positions unattainable with high powers. To observe an ascogonium for a long time, nothing remains but to keep the ordinary slide-cultivations in the usual way under moist bell-jars until spores are formed. A suitable

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Bot. Ztg., xlv. (1887) Nos. 13-7 (1 pl.). Cf. this Journal, ante, p. 791.

ascogonium is then sought for under the Microscope, and the position of the slide upon the stage noted by means of a piece of paper stuck thereon. This device enables us to remove the slide and replace it under the bell-jar for further growth, and thus the stages of development may be examined without difficulty. Medium powers (Zeiss D, Oc. 4) are only available, and these do not meet the requirements of all cases. If the pollinodium be evident, it may perhaps be followed up with this objective. The younger parts can be observed until the brown hairs appear, after which their growth stops. In selecting ascogonia for observation, such as are quite immersed beneath the culture-fluid must be chosen. But as the fungi stand in need of much oxygen, they usually die if, when removed from the culture-drops, they do not receive sufficient air. From the moment when the perithecium is quite closed it becomes more difficult to follow the fate of the ascogonium.

From very small perithecia some knowledge may be derived from cleared up sections. It may then be noticed in young fruit-organs in which the hyphæ almost completely close up that the ascogonium is quite unchanged. For further examination the assistance of the knife is required. Axial longitudinal sections may be made in the following manner:—Pieces of elder pith cut smooth on one side are soaked in plum decoction until quite saturated therewith. The process, which is slow, may be hastened by frequent and prolonged boiling. Upon the smooth side of the pieces thus prepared spores are sown; these develop so that the perithecia stand vertical to the pith-surface. The fungi, having sufficiently grown, the piece of pith is laid in osmic acid; after hardening they are washed and then imbedded in glycerin jelly. It is also advisable to shave off a thin layer which carries the perithecia and imbed it in glycerin jelly. In both cases the gelatin is hardened in spirit, and then longitudinal sections of the perithecia are made. Imbedding may also be made in ordinary gelatin and in celloidin, but the latter is only suitable for young perithecia. Orienting perithecia under a dissecting Microscope and fixation on elder pith is only possible in the adult stages where the ascogonium formation has already begun, as in this case there is a safe criterion between apex and base. The author finds, too, apart from the fact that the ascogonium does not always lie centrally, and that every axial section does not afford correct information as to the relation of the carpogonium, that it is difficult to decide whether a section is accurately axial or not.

Osmic acid facilitates the examination, as it stains the hyphæ of the carpogonium brown or brownish yellow. The same colouring also appears in the old cells which proceed from the ascogonium.

Some Novelties in Bacteriological Apparatus.*—(1) *New form of Incubator*.—Dr. M. Schottelius has devised an incubator which, though unprovided with a gas-pressure or thermo-regulator, does not vary summer or winter more than 0.15° . The incubator contains two approximately cubical compartments (50 cm.), and consists of a double-walled box of zinc plate 1.37 m. long, 0.80 m. deep, and 0.80 m. high. Between the double walls circulates a layer of water 10 cm. thick, except at the top, where the layer is 20 cm. thick. The box is subdivided by a median partition, also double-walled and filled with water. The capacity of each chamber is therefore about $1/8$ cubic metre. Access to the chamber is obtained by two double-walled zinc doors filled with a layer of ashes 10 cm. thick. The doors are placed at opposite ends of the long sides of the incubator. At the lower part of one of the shorter sides is a tap for letting off the water. Between the inner wall of the door and the incubator space is a

* Centralbl. f. Bacteriol. u. Parasitenk., ii. (1887) pp. 97–102.

plate of glass fitted in a frame of wood and covered with felt. The incubator is encased in wood, and stands 55 cm. high. Three thermometers, each 72 cm. long, are employed to indicate the temperature of the water and of the two compartments. The scale is marked from 30°–50°, and subdivided into tenths of a degree in such a way that each division is 1 mm. distant from the next.

A constant temperature is obtained by means of two simple Bunsen burners fed direct from the meter usually kept at half power. By raising the burner 1 cm. the temperature rises a tenth of a degree, so that to obtain the desired temperature (37°), twenty slips of wood, each 1 cm. thick, will be required. If higher temperatures are desired, the burner must be altered. The heating action of the apparatus must of course be ascertained first of all empirically, but this is only required to be done once. It may be mentioned that the course of the circulation is from the floor upwards through the central partition, then right and left along the top, and then downwards to the floor again by the short sides. The thermometers are all encased in a copper sheath, and the floor of the incubator is also made of copper.

(2) A perfectly clear *Agar Medium*, which will withstand a temperature of 40° without melting, is produced in the following manner:—Obtain the raw material, the dried *Fucus spinosus* (the ordinary agar powder is of no use), and pick out therefrom the clear yellowish transparent pieces. Then weigh the pure agar thus obtained, and wash with a 2 per cent. hydrochloric acid for five minutes, then with ordinary water frequently changed and perfectly free from dirt. By frequent weighing the quantity of water is ascertained, and by addition of concentrated bouillon the desired consistence is attained. It must be noted that for this quality of agar 5–10 per cent. is required to produce a firm medium. The agar bouillon is then left to macerate all night at the ordinary temperature. The next day it is boiled in a water-bath and strained through a linen filter. The usual quantity of pepton and common salt is then added, and after being neutralized with carbonate of potash or soda, is heated once again in the water-bath for about half an hour. The agar solution is then filtered through filter-paper. It flows through clear but slowly. On account of its rapid coagulation it is well to filter direct into sterilized test-tubes or Koch's flasks. Produced in this way the agar medium is perfectly crystal clear, remains quite firm at 40°, but is, however, somewhat softer than the ordinary solution.

(3) *Glass vessels for observing potato cultivations, &c., in various gases* may be made by expanding as much as possible the lower part of the neck of Koch's flask of about 200 gm. capacity, and then cutting them off at the middle of the neck. To the upper somewhat conical end an air-tight glass cap is fitted on, and to the side of the bulb a thin glass tube about 10 cm. long is melted in. The latter tube is intended to communicate with the air-pump. The raw potato discs are pushed through the neck opening by removing the glass cap, and after the side tube is plugged with cotton-wool the flask is sterilized. The medium having been inoculated while the flask is held in the oblique position, the air-pump is connected with the side tube; the air is withdrawn and replaced with the desired gas. When full the side tube is melted up with a Bunsen burner. In case the access of impurities should be feared during inoculation, a narrow glass tube terminated by a small cap can be fitted to the larger cap, and then inoculation may be performed in a current of the gas selected by quickly removing the smaller cover. Absolute safety is attained by closing the rims with vaselin. The tap connecting with the air-valve must be triply perforated, so that the

closure of the air-pump is simultaneous with the opening of the gasometer. It is of course obvious that experiments with this apparatus can only be made up to one atmospheric pressure.

Cultivation of Bacteria on Coloured Nutrient Media.—Prof. A. v. Rozsahegyi has experimented with the following Bacteria in order to ascertain the effect of cultivation in coloured nutrient media, and the influence of the dye on their growth, and to acquire, if possible, a new criterion for the differential diagnosis of the various species:—(1) bacilli of blue milk and green pus; (2) bacilli of rabbit septicæmia and fowl cholera; (3) bacilli of mouse septicæmia and swine plague; (4) the Koch and Finkler-Prior comma bacilli.

The gelatin was stained with various anilin dyes, prepared in the manner used for staining cover-glass preparations, and with "*Tinctura Kermesina*" (cochineal). A few drops of the stain were added to a small flask of liquefied 5 per cent. gelatin, some of which was filtered into test-tubes and sterilized by steam. When set, the gelatin was deeply stained, but quite clear and transparent. The cultivations were made at a temperature of about 20° C., the ordinary temperature of a room.

In the result, it was found that in certain cases it was evident to the naked eye that the dye was taken up very freely (e. g. Finkler-Prior comma bacillus in methyl-violet), and the bacilli seemed very deeply stained; yet on microscopical examination they appeared so pale that no advantage accrued from the method of staining. The influence of the dye on the growth of the bacteria was very various, although the alkaline reaction of the gelatin was unchanged by the addition of the reagent. Vesuvium was the most active preventive of growth, and less so gentian, methyl-violet, and *Tinctura Kermesina*. The impairment of growth was most noticeable in the liquefying varieties, and the form of the liquefaction area was also altered; thus the Finkler-Prior comma bacillus, instead of growing quickly down along the inoculation track, spread downwards in a broad channel, presenting the appearance of a cultivation of Koch's comma bacillus. In the latter the characteristic air-bubble was usually scarcely visible. In the non-liquefying varieties, the surface growth only was as a rule impaired.

In most cases the colouring matter was unaffected by non-liquefying bacteria, and where a change was observed, this began at the bottom of the cultivation; the matter causing this decoloration must therefore be produced in the absence of air. Of the liquefying comma bacilli, Finkler's had no effect on methyl-violet, while both this and Koch's comma bacillus decolorized fuchsin in the fluid part, and methylen-blue in the solid. With methylen-blue the colour could be restored on shaking, the effect lasting in a cultivation of Koch's bacillus for days, but in one of Finkler's a few hours only.

With regard to distinguishing between very similar kinds of bacteria, the author found that rabbit septicæmia did not grow in gentian, but very strongly in vesuvium. Fowl cholera grew well in gentian, but not in vesuvium. Mouse septicæmia grew strongly in methylen-blue; swine plague very poorly. Cultivations of the Finkler-Prior and Koch's comma bacilli in fuchsin appeared pretty different; in methylen-blue the former lost colour more rapidly, and while it grew well, though slowly in methyl-violet, Koch's bacillus would not grow at all.

(2) Preparing Objects.

Preparing Supra-oesophageal Ganglia of Orthoptera.*—Signor G. Cuccato snips off the head of the insect with a pair of scissors, and pins it on cork. Thus fixed, the head is immersed in 0.75 per cent. NaCl solution. Then with the aid of scissors and forceps, the chitinous sheath, and the eyes, are removed from the supra-oesophageal ganglion, and the specimen removed to a watch-glass full of salt solution, wherein the tracheæ and muscles are removed. After a short time the object is placed for forty-eight hours in Flemming's mixture, and then having been well washed, the rest of the muscles and the fat are removed from the ganglion. It is next put in 36 per cent. spirit, and gradually hardened. After dehydration it is imbedded in paraffin. The sections were fixed down by Mayer's method, and stained with a saturated watery solution of acid fuchsin. The fixative used was Rabl's solution (chromo-formic acid and platinum chloride).

Treatment of Acari.†—Dr. C. Nörner remarks that Acaridæ should be treated according to their species and habitat. Such as live within a tissue, e.g. the *Acarus scabiei*, are best obtained by softening the scabs in a 10 per cent. potash solution for an hour, or perhaps better by allowing a weaker solution to act for a longer time. Very good results are produced by soaking the scabs for a day in a dilute mixture of potash, glycerin, water, and spirit. The mites are thereby rendered not too transparent and preserve their form well. A very good preserving fluid consists of equal parts of 90 per cent. spirit, glycerin, and water. When the scabs are sufficiently softened, they are teased out in dilute glycerin under a dissecting Microscope and all extraneous matter removed. Glycerin preparations may be ringed round with turpentine, with red sealing-wax dissolved in absolute alcohol or with gold size, &c. A good preparation should contain mites in all stages of development, that is to say, eggs, larva, nymphæ, male and female, and if possible the stage of exuviation. For such slides glycerin jelly is a better mount than glycerin. The free-living mites and ticks which infest the surface of their host are more easily obtained than the pit-digging itch insect. The feather ticks of birds are almost as numerous as the species of birds. These are obtained by laying feathers under a dissecting Microscope and removing the animals with the needles; the breast feathers of small birds require to be placed in a dilute potash solution from which they are picked out under the Microscope. The histological structure of the Acaridæ is best studied in the living animal immersed in a drop of oil, glycerin, or water. The author has also used a mixture of glycerin, spirit, acetic acid and eosin, where these reagents were extremely dilute. To prevent the animals from being crushed during the microscopical examination it is only necessary to support the cover-glass on two others.

Very pretty pictures may be obtained by staining: for his purposes Ranvier's picrocarmine is the most generally useful. Other staining fluids recommended are (1) a mixture of equal parts of picrocarmine and indigo-carmin, (2) eosin either in alcoholic solution or watery, to which 1/3 glycerin is added; (3) methyl-green; (4) ammonia-carmin; (5) Magdala red. Rosanilin and fuchsin are the most suitable for the cast-off skin. With regard to their receptivity for dyes it should be borne in mind that mites are very uncertain, some taking up none or with great difficulty, while

* Cuccato, G., 'Sulla struttura del ganglio sopra-esofageo di alcuni ortotteri,' Bologna, 1887.

† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 159-67.

others take up too much. Haller recommends boiling the mites, &c., in a mixture of aq. dest. and potash (2:1) and then mounting the chitinous framework of the head in glycerin slightly dilute, while Ehlers treated them with ammonia and oil of cloves, but the author had no success with either of these methods.

The structure of the tracheæ is best shown by slight staining with picrocarmine, illuminated by Abbe's condenser with central stop.

Sections of stained mites and ticks are prepared by immersing them in gelatin and hardening in alcohol. They are then imbedded in elder pith and so sectioned. Ova should be examined in dilute salt solution (glycerin swells their capsule too much) and without a cover-glass. Picrocarmine stains ova very well and clearly brings out the segmentation, which if unstained and in glycerin does not appear.

Preparation of Microscopical Parasites.*—Dr. Stoss obtains his preparations of Acaridæ by scraping off the scabs from the diseased animal and softening them in a 10 per cent. potash solution for half an hour. A little piece of the softened scab is then mixed with a drop of water and examined carefully under a low power ($\times 90$). A suitable *Acarus* having been discovered, it is removed from the action of the potash solution by pushing the slide to the right and the cover-glass to the left with a needle. The *Acarus* is then freed from all extraneous objects and left on the slide for mounting, or is transferred to a watchglass containing glycerin by means of a needle. The fluid, which is suitable for extracting the potash lye, for preventing the *Acarus* from drying, or for preserving the animal, consists of a mixture of equal parts of 90 per cent. spirit, glycerin, and water. The *Acarus*, immersed in a drop of this fluid, is sealed up with a rim of wax, paraffin, or asphalt run round the cover-glass, but dammar or Canada balsam dissolved in chloroform or xylol are probably better and more durable.

When the *Acari* exist in quantity among the scabs and scales, and there is no difficulty in obtaining a good specimen, as, for example, is usually the case in cat's mange, the following procedure is recommended:—The scales are put for some time in the potash solution, and are then washed in distilled water several times. The *Acari* and scales are allowed to settle at the bottom of the vessel, and the supernatant fluid decanted off. The glycerin-spirit mixture is then poured over them, and in this they may be kept for an indefinite period without undergoing any change.

Psorosperms are well preserved in the glycerin-spirit mixture, but the proportions are different (1—1—2 water). And it is noticeable that different objects require slight alterations in the quantities of the constituents in order to produce an equilibrium between the contracting action of the spirit and the swelling action of the glycerin. Thus *Oxyuris mastigodes* remains quite intact in a fluid of 1—1—2, while *Filaria* shows fine surface-creasings, which do not appear with a little more water.

Although these parasites keep very well by the foregoing methods, they are extremely susceptible of mechanical injury. Damage from this cause is avoided by mounting in glycerin jelly. This medium is produced by softening gelatin by leaving it all night in water. It is then cut up and fluidified in a water-bath without the addition of water, and mixed with 10 per cent. glycerin and 1 per cent. carbolic acid. When cold the mass is cut up and kept in stoppered bottles. A mite or tick is mounted by placing small bits round it on a slide and then warming gently over a

* Deutsche Zeitschr. f. Thiermed. u. Vergl. Pathol., xii. (1887) pp. 202-5.

spirit-lamp. When the jelly is melted a warm cover-glass is imposed. If the mass should swell up over the cover-glass, it is easily removed when cold.

Investigation of Histology of Eunice.*—Prof. E. Jourdan reports that the use of alcohol at 90 per cent. has always given him the worst results with Annelids, and that the same has been the case with picric acid; when either of these reagents has been used the elements of the tissues are quite beyond recognition. The use of 2 per cent. solution of bichromate of ammonia, of bichloride of mercury, either saturated, as Lang's solution, or in a 5 per cent. solution, was more successful. Osmic acid (1 in 200 parts) was the best reagent for the study of the antennæ and the delicate organs in general, and was always regarded as a good means of control for observations made after the use of other reagents. After the use of these fixing solutions, the specimens were washed and then placed in alcohol of increasing degrees of strength up to 90 per cent. The alum-carminé solution of Grenacher was most used in staining. Celloidin was used at the commencement of the research, but was not found to present any advantage over paraffin; the mixture of Schällibaum was found excellent in fixing the pieces after placing in paraffin, and they were thus completely coloured. The plates carrying the series of sections were treated with various strengths of alcohol, dehydrated by absolute alcohol, and mounted in Canada balsam.

Prof. Jourdan found greater difficulty in his teasing; the most successful method was one which has been used to isolate the nerve-tubes of Vertebrates. Fresh pieces were treated with one-hundredth solution of osmic acid, and were then allowed to macerate in weak alcohol or even distilled water. Specimens preserved for a year in bichromate of ammonia were also successfully teased in a drop of hæmatoxylic glycerin, to which a drop of glycerin was added for examination and preservation.

Preparing Epithelia of Actiniæ.†—Dr. J. H. List used the tentacles of *Anthea cereus* and *Sagartia parasitica* in his examination of the epithelia of Actiniæ. The tentacles were snipped off in the vessels in which the animals were kept alive, and when the contraction due to the irritation had passed off, the greater part of the sea-water was removed with a pipette, only so much being left as would serve to keep the specimen moist. The tissue of the tentacles was then fixed with chrom-osmium acetic acid. This was allowed to act for ten minutes; the specimen was then washed, and after-hardened in spirit.

Isolation of the elements was effected by placing the tentacles in a vessel containing 100 ccm. sea-water and 30 ccm. Flemming's fluid (chrom-osmium acetic acid mixture). After allowing this to act for ten minutes, the tentacles were transferred to a large quantity of 0.2 per cent. acetic acid, wherein they remained for two to three hours. The specimens thus treated were afterwards placed in glycerin and water (equal volumes), and there teased out. Excellent isolation-preparations of the cells of the ectoderm were thus obtained; these kept extremely well, and further differentiation was obtained by staining with picrocarminé.

Breaking up Diatomaceous Rocks.‡—M. Guinard breaks up diatomaceous rocks by putting small fragments in a test-tube and covering them for about 2 cm. with crystals of commercial acetate of soda and then adding one or two drops of water. (On a larger scale the proportion of water is

* Ann. Sci. Nat.—Zool., ii. (1887) pp. 239-42.

† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 210-1.

‡ Bull. Soc. Belg. Micr., xiii. (1887) pp. 180-2.

5 ccm. to 100 of the salt.) The test-tube is then placed in a water-bath, and the contents dissolved at boiling-point. It is left for ten minutes in the hot water and then removed and allowed to cool gradually, or it may be cooled rapidly by plunging it in cold water. A small crystal of soda acetate is then dropped in, when, owing to its supersaturation, it at once crystallizes. By repeating this two or three times the rock is quite reduced to powder. However, very refractory rocks, such as those from Jutland, require five or six repetitions. The next step merely consists in adding water to excess to dissolve out the salt. Another substance, the hyposulphite of soda, may be used for the same purpose. The hyposulphite of soda and some bits of rocks are mixed up in a test-tube and heated in a water-bath to 48°. The salt deliquesces, and then having been allowed to cool, a small crystal is dropped in. Water is then added in excess to dissolve out the salt. Of course the operation must be repeated until the rock is properly pulverized.

The foregoing methods, the first of which is preferred by the author, are simpler than the sulphate of soda method of Brun.

HUEPPE, F.—Cover-glass Preparations in Bacteriological Investigations.

Amer. Mon. Micr. Journ., VIII. (1887) pp. 190-4, from Hueppe's

'Methods of Bacteriological Investigation,' *transl.* by Dr. H. M. Biggs (New York).

JAMES, F. L.—Preparing Crystals of Salicine.—Referring to the note at p. 507, Dr. F. L.

James further writes:—

"When, some months ago, I made note of the fact that I had hit upon the method of reduplicating the astonishingly beautiful slides of salicine accidentally made some years ago, I had little idea of the possibilities of that alkaloid in the way of strange and gorgeous groupings. Some of my later experiments in this direction have resulted in slides utterly throwing into the shade all former successes. The human eye never before dwelt on so wonderful and gorgeous phenomena as are presented in some of these latest slides. All laws and rules of crystallization seem to be set aside, and the material runs riot in its bewildering forms and combinations. The most beautiful auroras and most brilliant pyrotechnics fade into insignificance alongside some of the latest results."

St. Louis Med. and Surg. Journ., LIII. (1887) pp. 166-7.

QUIMBY, B. F.—Insect Preparation. II.

[Mounting—mounting insects as opaque objects.]

Microscope, VII. (1887) pp. 266-9.

(3) Cutting, including Imbedding.

Myrtle Wax Imbedding Process.*—Myrtle wax, or bayberry tallow, writes Mr. J. W. Blackburn, is a substance derived from *Myrica cerifera*. The wax is found covering the fruit as a whitish coat, and is separated by boiling the berries in water and removing the wax on cooling. It is of a pale greyish-green colour, somewhat diaphanous, brittle, slightly unctuous to the touch, is feebly aromatic, and a little bitter to the taste. Its specific gravity is about that of water, and its melting-point 46°·6 C.—48°·8 C. (116°—120° F.). It is insoluble in water, scarcely soluble in cold alcohol, soluble except about 13 per cent. in 20 parts boiling alcohol, which deposits the greater part of it on cooling. It is also soluble in boiling ether, and slightly so in oil of turpentine. It is very soluble in chloroform benzol and xylol. The foregoing account is descriptive of the true product of *Myrica cerifera*, but for the purposes of the microtometist it will not answer. A variety must be obtained which is yellowish-white in colour, tougher and softer. This variety is probably the product of *Rhus succedanea* Ln., and should be called "Japan wax."

Dr. M. N. Miller, who first described this method,† states that "bayberry tallow is firm and solid at ordinary temperature, and is solid in warm alcohol." He states that specimens may be removed from the alcohol in

* *Amer. Mon. Micr. Journ.*, viii. (1887) pp. 164-5.

† *N. York. Med. Record*, xxvii. (1885) p. 429.

which they have been preserved, and placed at once in a bath of melted wax; but the author thinks it is better to first dehydrate in absolute alcohol, and then place in a preliminary bath of wax dissolved in chloroform. Benzol and xylol will dissolve large quantities of the wax, but it is deposited in a granular form on their evaporation; but after solution in chloroform the wax is left in a solid form. Hence chloroform is preferred as a solvent for the preparatory bath, but for all other purposes the less expensive reagents may be used. The chloroform may be used over and over again, and if occasionally a little fresh be added to it, the bath may be kept always ready.

The method of using myrtle wax is as follows:—The specimens are dehydrated in absolute alcohol and then placed in a solution of wax in chloroform as a preliminary bath, or transferred directly to the melted wax. The pieces will be infiltrated in about the same time required by the paraffin method. The pieces may be fastened on cork, by using the melted wax, or imbedded in blocks of wax or paraffin to support the specimen in the clamp of the microtome. The sections are cut dry into benzol, washed in alcohol, stained and mounted as usual. To completely remove the wax, it is best to take the sections through a second bath of benzol, as any remaining wax will be precipitated by the alcohol used in the washing. Warm absolute alcohol may be used to free the sections from wax, but the benzol is better and cheaper. Ordinary alcohol warmed will not dissolve the wax perfectly. Warmed absolute alcohol will dissolve most of it, but will deposit it on cooling. The author therefore thinks that the above method is preferable to the immediate transferring from the preserving alcohol to the wax-bath, as advised by Dr. Miller. The method is more rapid than the paraffin or celloidin process; there is very little if any shrinkage; it does not injure the most delicate tissues; and it is inexpensive. If hardened in large masses there is slight shrinkage and a tendency to crack; this may be prevented by the addition of a small amount of paraffin, with which it is miscible in all proportions. The author states that he has never seen a section injured by cracking.

De Groot's Automatic Microtome.*—Herr J. G. de Groot's instrument (fig. 248) consists of a rectangular frame, supported on four feet. To the long sides of this frame are fitted two cylindrical bars, upon which the object-carrier slides. The latter is a metal plate *b* faced with ebonite, and supported on the slide rails by four feet: on its under side are two vertical bars, joined at their ends by a cross-piece, from the centre of which uprises a thick screw, and this latter passes through a threaded ring *r*. This screwing supports two vertical bars, the upper ends of which pass through openings in the metal plate and are then again united by a second ring. To this last is fixed a third ring *c*, which supports a cup-shaped tube *d* filled with paraffin for the reception of the object to be cut. At the lower end of the main screw is a horizontal cog-wheel *e* by the movement of which the ring *r* and with it the object-holder *d* are raised or lowered. The to-and-fro movement of the object-carrier is effected by means of a rod which connects with the large wheel *f*. The extent to which the screw is turned in the to-and-fro movement is regulated by the escapement *a*. This is a rod with rack which works up and down in a box and is fixed by a screw. When the object-carrier moves backwards, the teeth of the rack grip those of the toothed wheel *c*, so that the more they are engaged the deeper the rod is pushed in. This depth is easily determined from the figures on the rod, but it must be noticed that the hinder side of the box coincides with the

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 145-8 (1 fig.).

streaks upon which the numbers stand. When the slide is pushed forwards the toothed rod is disengaged from the wheel, and is replaced by another

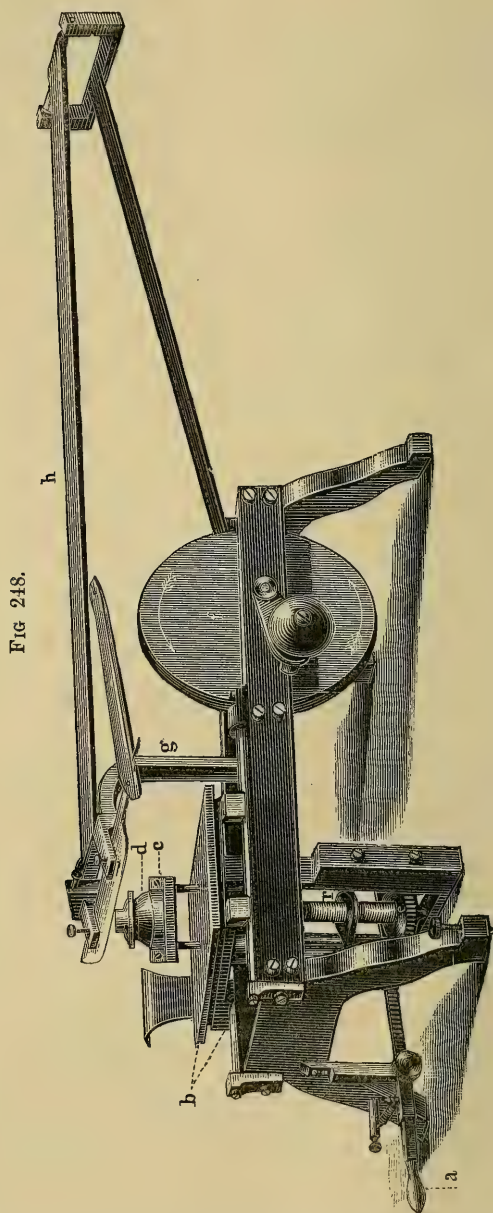


FIG 248.

DE GROOT'S AUTOMATIC MICROTOME.

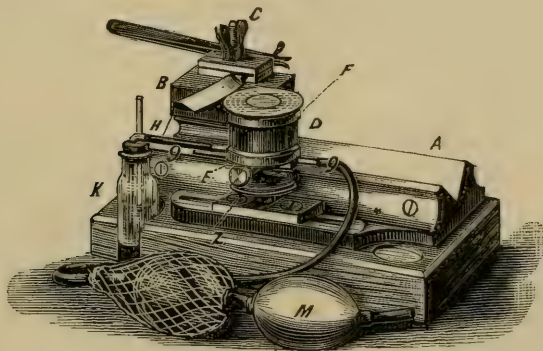
simple arrangement not shown in the illustration. The cog-wheel *e* has 150 teeth, and as one complete turn raises the object $\frac{3}{4}$ mm., one tooth represents an ascent of $\frac{1}{200}$ mm.

The knife-carrier *g* terminates in front in two openings, through which the knife is passed, and is there fastened by means of two screws. The cup-shaped object-holder *d* fits accurately in the ring *c*. One-half of the latter is movable and fixed by two screws, so that the preparation may be placed in any desired position. The object is imbedded in the usual manner in pure paraffin, and is then melted in the cup filled with hard paraffin. The cup is then fixed in the ring in such a manner that one surface of the paraffin mass is parallel to the knife. When cutting, each section is pushed off the knife by its predecessor, and adheres to it so that a ribbon-like strip is produced, and this is taken upon a brush and placed on the band *h*. This band moves over two rollers, one of which is attached to the front side of the microtome, the other to the knife-carrier *g*. The first section is stuck firmly to the band, the lower side of which is pulled by the left hand, so that the whole series of sections eventually lie on the upper side.

Excellent sections of the frog's embryo, and series of sections of the embryos of *Erinaceus* and *Gallus domesticus*, which are 15 mm. long, have been prepared by this instrument, which is also said to work very quickly, so that 1000 sections can be prepared in ten minutes. The fig. represents the microtome about $1/5$ its natural size.

Hayes's Ether Freezing Microtome.—This instrument (fig. 249*) was designed by Dr. R. A. Hayes with the object of affording to those who have occasional need to cut sections of tissues for pathological investigations, &c., with the means of doing so quickly, conveniently, and accurately. It is

FIG. 249.



very compact, solidly constructed, and simple in plan. It freezes rapidly, and permits sections of large surface to be made with precision, sections 1 in. \times $5/8$ in. having been cut by it without difficulty.

It consists of a solid cast-iron base *A*, 10 in. \times $4\frac{1}{2}$ in., which rests upon a mahogany block. Extending the whole length of the upper surface of the base is a V-shaped gutter, on the planed sides of which slides a heavy metal block *B*, on the flat top of which the razor is secured (any ordinary razor can be used), the tang being grasped between two flat pieces of iron, which are pressed together by a winged nut *C*. The razor by this arrangement can be secured at any desired angle to the direction of its motion to and fro.

The freezing chamber is formed by a short vulcanite cylinder *D*, its

* The block is supplied by the author, but hardly does justice to the apparatus.

lower end being screwed into a brass base E. To its upper end is fastened by two bayonet-catches a brass plate F, on which the tissue to be cut is placed. Inside the cylinder D, and rising from the base E, is an ordinary spray, the air and ether being supplied through tubes G and H, passing outside, through the base. There is also an opening in the floor of the chamber communicating with the tube I, to allow the overflow of ether in case of any accumulation inside the cylinder; any such overflow may be returned by the tube to the ether supply bottle K. The freezing chamber is secured to the top of the micrometer-screw arrangement Z, which is of the simplest form, but has a perfectly smooth and regular motion. The nut is divided to indicate a section 0.01 mm. in thickness, but half this thickness can be cut without difficulty.

The method of using the microtome is very simple. The slide and block D having been carefully rubbed clean and well oiled, the razor is clamped at any desired angle, the bottle K is filled with ether (good dry methylated ether answers perfectly), and the piece of tissue to be cut having been previously saturated with thick gum solution, is placed upon the plate F, and the spray which plays upon the under surface of the plate F set working by the hand-pump M; in a short time the tissue will be frozen quite through, and if a number of sections are required, an occasional stroke or two of the pump will keep the gum in proper condition for cutting. The sections are easily cut, as in other microtomes of this class, by alternate movements of the screw Z and stroke of the razor.

The instrument may also be used for cutting tissue imbedded in paraffin or other mass, the object to be cut being secured in position, either by being gently heated at its under surface and pressed on the plate F, to which it firmly adheres on cooling, or by a simple clamping arrangement, which can be substituted for the freezing-chamber. When used in this way large numbers of sections may be cut in series by attaching to the razor a light support to receive the sections as they are cut.

Paoletti's Automatic Microtome.*—Sig. E. Paoletti has invented an automatic microtome, which is said to answer perfectly. To a rectangular vertical upright are adapted two guides, between which the object-carrier moves vertically. The carrier is fitted with a clamp, movable in all directions. A micrometer screw, to which is fixed a toothed wheel, moves the carrier vertically upwards. Another wheel fixed to the upper end of a vertical plate is moved with this in a horizontal plane by a movement of rotation, which is transmitted to it by a lever. From the periphery of the wheel projects a vertical tooth, which, acting excentrically, displaces with a to-and-fro horizontal movement a knife-carrier, the level of which is a little higher than that of the clamp containing the preparation. At the lowest part of the plate is another tooth, which, as the instrument works, meets at intervals of about half the circumference the teeth of the cogwheel, and by locking with these imparts to the screw a displacement which serves to raise the object-carrier. Now in one complete turn of the plate the movement of the knife takes place in one half, the raising of the specimen in the other half. The tooth which causes the cogwheel to revolve can be approximated to or removed from the latter by a milled head, and thus displace it by a greater or less segment, according to the thickness desired to be given to the sections. According to the distance of the tooth from the cogwheel, the latter can be displaced by a fifth to a twenty-seventh of the circumference, and thus a thickness varying from 0.1 to 0.02 mm. can be given to the sections.

* Atti Soc. Tosc. Sci. Nat.—Proc. Verb., v. (1887) pp. 250-1.

BLACKBURN, J. W.—On Methods of preparing Tissues for Microscopical Study, and Brains for Anatomical Demonstration.

[Freezing method. Hardening agents. Interstitial imbedding. Myrtle-wax imbedding process, *supra*, p. 1048. Wax method applied to the preparation of brains for anatomical demonstration.]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 161-5.

GAY, G.—[Home-made Microtome.]

["The materials needed are a block of hard wood 5 in. by $3\frac{3}{8}$ in. by 2 in., a fine thumbscrew with a nut on it, a piece of glass tubing, and a glass slide cut lengthwise through the middle. Plane the top of the block perfectly true, then bore a hole, the centre of which should be $1\frac{1}{2}$ in. from the end, which the glass tube will exactly fit. Saw a strip from the bottom of the block, and fit the nut in the hole. Cement the glass tube in the hole in the large block with marine glue, allowing it to project through nearly the thickness of the glass side. Cement the glass slips on the top touching each side of the tube. Fit a block of wood $1\frac{1}{4}$ in. long, with a rivet in the bottom, so that the thumbscrew will work smoothly on it, to the glass tube. Screw the $\frac{3}{8}$ in. strip with the notch in it to the block, and cut a notch $1\frac{1}{4}$ in. by $2\frac{1}{2}$ in. in the block to fasten it to a table, and the microtome is complete. Sections may be cut with a flat or common razor."] *Microscope*, VII. (1887) p. 287.

KRYSINSKI, S.—Beiträge zur histologischen Technik. 1. Photoxylin als Einbettungsmittel. 2. and 3. see Staining. (Contributions to histological technique. 1. Photoxylin as an imbedding medium.)

Virchow's Arch. f. path. Anat. u. Hist., CVIII. (1887) pp. 217-9.

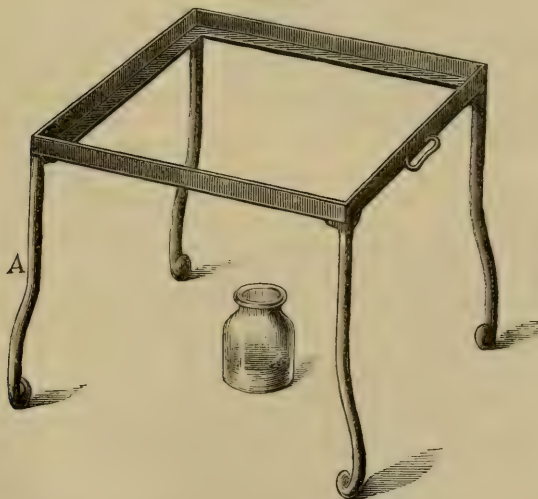
LATHAM, V. A.—The Microscope and How to Use It. XII. Section-cutting.

Journ. of Micr., VI. (1887) pp. 238-48.

(4) Staining and Injecting.

Perényi's Mikroelektron, for hardening, staining, and imbedding.*—Prof. J. v. Perényi has devised an apparatus, which he calls a "Mikroelektron," for facilitating the processes of hardening, staining, and imbedding without incurring the risk of damaging the preparation. Figs. 250-252

FIG. 250.

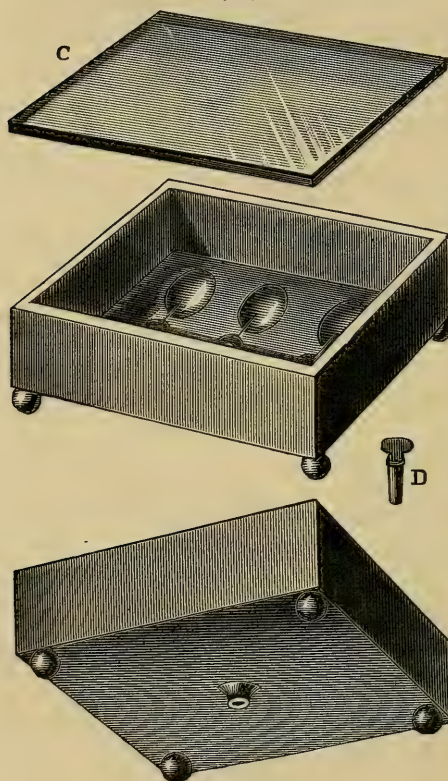


give a complete idea of the apparatus, which is nothing more than a rectangular vessel made of glazed majolica, and placed for convenience on a metal stand A (fig. 250). A dish of the size recommended, measures 16 cm.

* *Zeitschr. f. Wiss. Mikr.*, iv. (1887) pp. 148-52 (3 figs.).

long, 16 cm. broad, and 6 cm. high, and holds 500 ccm. of fluid. On the bottom (figs. 251 and 252) are seen six oval pits, each holding 50 ccm. of fluid. These pits communicate by narrow channels with a deepish central hollow, in the middle of which

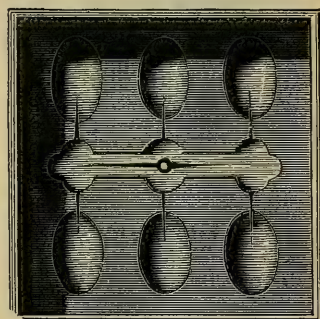
FIG. 251.



is a hole, closed when the vessel is in use by a plug D (fig. 251). The dish or tray is covered with a glass top C.

The way to use this ap-

FIG. 252.



paratus is of course obvious; the various fluids are simply poured in through a funnel, and after the necessary time are withdrawn by removing the plug D. Imbedding with paraffin is executed by putting some soft paraffin in the mid-channel, and then transferring to an incubator. When melted the paraffin finds its way into the egg-shaped pits, and thus

saturates the preparation. The excess of soft paraffin having been withdrawn by removing the plug, the process is repeated with hard paraffin. It is not necessary to use an incubator, a naked flame answers the purpose. Celloidin or any other imbedding medium can be manipulated in the Mikrolektron. After using the apparatus, it is advisable to clean out the cavities and channels by the aid of heat and absolute alcohol.

Method of Staining and Fixing the Elements of Blood.*—Recent discoveries of morphological elements in the blood hitherto unknown, as well as the newly-published facts concerning its coagulation, have aroused an interest in the subject which calls for an acquaintance with the methods with which it is possible to follow those results. Accordingly, Miss Alice L. Gaule describes the method employed in the Physiological Laboratory, Zurich; for, although it has been mentioned by Prof. Gaule in his lectures for several years, it has not as yet been published.

The methods formerly used were that of examining fresh blood, and that, perfected by Ehrlich, which consisted in staining dried blood.

* Amer. Natural., xxi. (1887) pp. 677-83.

The new method consists in a series of manipulations requiring only thirty-five minutes for their completion. The following is a list of the reagents, together with the length of time and the order in which each is to be used:—

	Mins.
1. Corrosive sublimate (concentrated solution)	6
2. Distilled water	1
3. Absolute alcohol	5
4. Distilled water	1
5. Hæmatoxylin (1/2 per cent. alum solution, to which, for every 100 ccm. employed, 20 drops 5 per cent. alcoholic solution have been added) ..	6
6. Distilled water	1
7. Nigrosin (1/2 per cent. water solution)	1
8. Distilled water	$\frac{1}{2}$
9. Eosin (1 gr. eosin dissolved in 60 ccm. alcohol; 140 ccm. distilled water)	2
10. Alcohol	5
11. Oil of cloves	1-2
12. Xylol.	
13. Canada balsam (diluted with xylol until it readily flows).	

As receptacles for these fluids, each person has upon his table three shallow glass dishes with flat bottoms, so large that a slide may be easily put in and taken out of them. Into the first of these is poured corrosive sublimate, into the second distilled water, and into the third absolute alcohol. It is necessary either to label the dishes or to place the two not at the moment in use at one side. For the colouring fluids bottles are used whose stoppers serve at the same time as droppers or pipettes. The most convenient form is the glass stopper, which broadens into a funnel, closed by a rubber membrane. For oil of cloves, xylol, and Canada balsam wide-mouthed bottles are used. In the first two bottles are brushes; in the last, the ordinary glass rod. Other necessary utensils are a glass rod, sharp-pointed scissors, clean slides and cover-slips, filter-paper, twine or coarse thread, a small bottle of absolute alcohol, a sharp, clean needle, a fine clean rag, and a hand-towel.

Aside from these, a board, 5 by 15 in., with two pairs of holes, large enough for a piece of tape to pass through double, is an essential help. The first pair of holes should be 4 in. distant from the second, and the two holes of each pair $1\frac{1}{2}$ in. apart. The tape should be so passed through the holes that there will remain upon one side of the board loops, on the other long ends, by which, upon passing the extremities of the frog through the loops, one may easily and firmly tie the frog upon the board. Such preparation is necessary, otherwise the manipulations cannot follow one another quickly enough. After these preliminaries have been completed, the labelled bottles being placed within reaching distance, the distilled water and alcohol in front of these, and the corrosive sublimate nearest of all, we are ready to bind our frog upon the above-mentioned board and begin our preparation. We make use of the frog for this purpose at first, since its blood coagulates less quickly than that of mammals. The vena femoralis, which may be seen as a dark blue line below the knee-joint on the inner side of the leg, having been snipped, we quickly bring with a glass rod a drop of the blood which comes from the wound upon a slide previously moistened by the breath, and throw the whole into the dish of sublimate for six minutes. If a little care is taken to spread out the drop of blood in putting it on the slide, the result is more satisfactory. Brought from the sublimate into the dish of water, we find that the greater part of the blood adheres to the slide. The superfluous sublimate being washed from the preparation during the moment that it remains in the water, we next

partially dry the slide by resting it upon filter-paper before dropping it into the alcohol-bath. The slide, which has remained in alcohol six minutes, is brought again into distilled water for half a minute, since our colouring fluids are water solutions. The hæmatoxylin is then dropped upon the slide, and removed again at the end of six minutes by resting the edge of the slide upon filter-paper, and afterwards washing with distilled water for one minute. The same process follows with the nigrosin and eosin, the first remaining upon the slide for one minute, the second two minutes. From the eosin we bring the preparation directly into alcohol, since the eosin is partially an alcohol solution. At the end of five minutes the slide is taken out of the alcohol, and, in order to be quite sure that there is no water still clinging to the preparation, we incline the slide at a slight angle to the rag with which we are holding it, and pour a few drops of alcohol from the small bottle over it. If upon dropping oil of cloves on the preparation it should be dark upon a dark sleeve or other dark background, we may remove the oil of cloves with a few drops of xylol. Having quickly cleaned the slide close up to the preparation, we place a drop of Canada balsam upon it, which must be allowed to spread out before the cover-slip is lowered upon it.

Human blood is prepared in the same way, except that here the fingertip undergoes the surgical operation.

Mitosis Staining.*—Dr. H. Zwaardemaker states that mitoses are most successfully stained by the aid of a mordant. For hardening he usually employs Flemming's chromo-osmium-acetic acid mixture, and then stains the sections with an anilin-safranin solution. This is made by pouring an alcoholic solution of safranin into about an equal volume of anilin water. In this stain the sections remain from two minutes to an hour, the exact length of time depending on the softness or the compactness of the tissue. Decoloration is performed with slightly acidulated spirit.

Colouring the Nuclei of Living Cells.†—The most interesting fact brought out in Mr. D. H. Campbell's work at Tübingen is the fact that several anilin colours have the property of colouring the nucleus of many plant cells without killing them. That the living nucleus can be stained has been demonstrated by several observers in the case of animal cells, but as far as he knows, it has not hitherto been observed in plant cells. Though the work is not yet completed, he thinks it will be interesting to give briefly some of the processes by which the results were obtained, and some of the objects employed.

The first colour used was dahlia, a violet-purple pigment, by whose aid Lavalette had succeeded in colouring living spermatozoa and the nuclei of sperm-cells. The most favourable object so far found by the author is the nucleus of the cells of stamen hairs of *Tradescantia*. *T. Virginica* was principally used, but other species gave equally good results. Hairs should be chosen from young buds, as these are perfectly colourless, not having developed the coloured cell-sap of the older hairs. The sepals and petals are removed, and the stamens thus exposed are plunged into an aqueous solution of the dahlia. After an immersion of from half an hour to three or four hours, or even much longer, depending on the strength of the solution, it will be found that in many cases the nuclei are more or less deeply coloured, and that the cell is not killed is evinced by the continuance of the protoplasmic streaming. It is quite surprising to see how deep the nucleus is often stained without killing the cell. A nucleus so coloured appears

* Zeitschr. f. Wiss. Mikr., iv. (1887) p. 212. † Bot. Gazette, xii. (1887) pp. 192-3.

perfectly normal, there being no distortion or change beyond the change in colour. As yet he has not studied especially what parts of the nucleus are coloured, but it appears to be the nucleolus and microsomes only, as in the case of cells that have first been killed and then stained according to the ordinary methods.

Among other objects that have given more or less satisfactory results were the hairs from the base of the perianth of *Lilium bulbiferum*, stamen hairs of *Aphodelus albus*, leaves of *Elodea Canadensis* and *Vallisneria spiralis*, root-hairs of *Trianea Bogatensis*, *Cucurbita Pepo*, *Tradescantia zebrina*, spermatozoids of *Chara* and a fern (probably *Blechnum*). In all cases cells were chosen in which there was evident protoplasmic movement, in order that there might be a certain means of determining whether or not the cell was still living.

Similar and usually quite as good results were also obtained with mauvein and methyl-violet, both colours closely resembling dahlia. Usually a 1 per cent. solution was made, and this diluted with from 50 to 1000 parts of water, according to circumstances. Some doubtful results were obtained with other colours, but too uncertain to warrant recording.

Absorption of Anilin Colours by Living Cells.*—Referring to Pfeffer's experiments showing that, contrary to the ordinarily accepted idea, various anilin colours can be absorbed in large quantities by living cells, Mr. D. H. Campbell calls attention to some easily made but instructive experiments bearing on the subject.

Pfeffer's experiments were mostly made with methylen-blue and methyl-violet, though numerous other colours were also tried. Among colours not employed by him, the author found that dahlia and mauvein, both very similar to methyl-violet, were quite as good, and acted much in the same way. The yellow colour chrysoidin also gave good results. No very satisfactory results were obtained with red pigments, though in some cases safranin, tropæolin, and fuchsin gave tolerably good colouring, but either it was too diffuse or the cell-wall was more deeply coloured than the contents.

With methylen-blue either the cell-sap is coloured, often very intensely, e. g. root-hairs of *Trianea Bogatensis*, or a precipitate is formed in the cell-sap, e. g. *Spirogyra*. If vesicles of tannic acid are present, as is the case in *Zygnema*, these are coloured dark blue. Methyl-violet, dahlia, and mauvein colour the protoplasm and nucleus, and are specially valuable in the study of the latter. In some cases they are also precipitated in the cell-sap. Chrysoidin appears to colour only the protoplasm. The following are some of the objects that were used:—Root-hairs of *Trianea Bogatensis*, *Cucurbita*, *Tradescantia zebrina*; stamen-hairs of various species of *Tradescantia*; *Spirogyra* spp., *Zygnema* spp.; roots of *Lemna minor*; leaves of *Elodea* (*Anacharis*) *Canadensis*, *Vallisneria spiralis*; pollen-tubes of *Hemerocallis* spp., *Tradescantia Virginica*, *Scilla* spp.; spermatozoids of *Chara*.

The objects are placed in a solution of 0.002–0.001 per cent., varying with the nature of the cell-wall and the time of immersion. Root-hairs are usually especially delicate, and the solution should be very dilute or the immersion very brief.

In most cases objects were selected where there was marked protoplasmic streaming, as this is the best means of determining whether the cell is alive or not. It is surprising how deeply the protoplasm or nucleus may be stained without materially affecting the streaming. For a demonstration of the staining of the protoplasm the root-hairs of *Trianea* were found to be

* Bot. Gazette, xii. (1887) pp. 193–4.

specially favourable, on account of their large size and the rapid streaming, as well as the readiness with which the colour is absorbed.

Staining Pathogenic Bacteria with Anilin Dyes.*—Dr. C. Günther, when dealing with pathogenic bacteria, usually employs Ehrlich's anilino-gentian solution, Löffler's potassium methylen-blue and Ziehl's carbolic-acid fuchsin solution. Dry preparations stain better if before staining they are washed with 1–5 per cent. acetic acid, and, if they have been kept unstained for a long time, with a 2–3 per cent. watery pepsin solution.

The author discusses Koch's method for staining tubercle bacilli with the improvements of Ehrlich and Rindfleisch, and recommends the Ehrlich procedure as the best and safest in practice. Gram's method is advised for the pneumonia cocci of Friedländer and Fränkel, for the cocci of pyæmia and erysipelas, for the bacilli of anthrax, lepra, and tubercle, and for actinomyces. On the other hand, Gram's treatment is quite unsuited for gonococci, bacillus of typhus, of glanders and of cholera, and also for the spirochæte of recurrent fever. For preparations which have been a long time in bad spirit and which resist decoloration by Gram's method, the following modification is recommended:—Stain the sections for 1 minute, dry with blotting-paper; decolorize for 2 minutes in the iodide-iodine solution, then 1/2 minute in spirit, then 10 sec. in 3 per cent. hydrochloric acid alcohol, after this the sections are transferred to spirit. An inconvenience appertaining to Gram's method, in the deep-staining of minute fat-globules, is best avoided by treating the specimen before it is stained with chloroform, and then washing with absolute alcohol. In order that the sections may be well stained it is advisable that not more than two or three should be manipulated at a time, as decoloration is often difficult. For double staining, the author recommends the ordinary nuclear stains for contrasting with the stain of the micro-organisms. For erysipelas sections stained by Gram's method, a double stain is best effected by previously using ammonia-carmin or picrocarmin, a procedure which will be found more suitable than after-staining. The preparations are best mounted in xylol balsam; and decoloration of tubercle and lepra bacilli, both in sections and in cover-glasses, is most perfectly avoided by the dry method as recommended by Unna.

Staining the Bacillus of Glanders.†—Dr. G. M. Sternberg says that these bacilli are best stained with a concentrated alkaline solution of methylen-blue. For staining the bacilli in sections of tissue containing them, Löffler recommends that they be immersed in the above-mentioned solution for 12 to 24 hours, and then very carefully treated with very dilute acetic acid until the sections have been decolorized sufficiently to bring the bacilli into view. After this treatment they should be washed in alcohol, and immersed in oil of cedar, which does not dissolve the anilin colours, and is therefore to be preferred to oil of cloves in all preparations in which these colours are used for staining bacteria.

Anilin Stains.‡—Dr. S. Griesbach's experiments on the anilin dyes lead him to the conclusion that between the constituents of the dyes and those of the tissues direct chemical combinations according to the laws of affinity are effected, and therefore all those forces which have a promoting, retarding, or destructive influence on affinity play a part in the staining process, while above all influences is the capacity for a saturation of the tissues with free gases, or, as Ehrlich expresses it, the gas saturation. The intro-

* Deutsche Med. Wochenschr., 1887, No. 22.

† Microscope, vii. (1887) p. 309, from Med. News.

‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 358–85.

ductory remarks close with a reference to the so-called mordants, the effect and use of which is well known. The author believes that for microscopical research such aids are of little or no value for staining purposes, as much of what is afterwards seen and described in the preparation must be ascribed to structural alterations due to the action of the mordants.

After enumerating the various anilin dyes, the classification of which is adopted from Hummel,* the author proceeds to discuss the characters and staining properties of Congo red and benzo-purpurin. Congo red is soluble in water, the solution being bromide-red. The specific gravity of the commercial article is 2.2149. The reaction of the chemically pure preparation is neutral, that of the trade preparation alkaline. To obtain this pure article the dye is dissolved in about 20 parts water, and is then precipitated by the aid of heat with an equal volume of saturated salt solution. After cooling, the dye is washed off the filter with the salt solution. The least quantity of a free acid turns the Congo solution blue, hence Congo is a delicate test for a free acid. This double action has been turned to account for demonstrating the presence of free acids in certain animals, and the alkaline reaction of the living tissue in others. According to the author, the watery solution of Congo is alone suitable for microscopical purposes, for, although miscible with glycerin and turpentine oil, the results therefrom are not satisfactory. For tissue staining, a concentrated watery solution stains both fresh and preserved material. Blood-corpuscles must be dried at 80° for twelve hours before using the watery solution, otherwise the action of the dye quite destroys the tissue. With regard to the staining of animal tissue generally, it appears that the plasma takes up the stain more freely than the nuclei, which are frequently devoid of colour. The hue varies from yellow to red, and preserved material stains better than fresh. One interesting example of its action is that of a section of a fibroneuroma, in which the connective tissue became of a dark orange, and the nervous tissue received a bright-orange stain. Transverse sections of nerves only stained in the sheaths, the axis-cylinder being unaffected.

Benzo-purpurin is obtainable in two shades, 1 B and 4 B. It is soluble in water, and has approximately the same hue as Congo, but is not affected by acids in the same way as Congo. Its reaction is neutral. Cover-glass preparations dried for ten hours at 200° are said to be successful. In general the stain is somewhat similar to that of Congo, but as a rule the hue is redder.

Rosanilin and Pararosanilin.†—Dr. P. G. Unna has tried to solve the question whether the appearance of lepra bacillus as threads containing cocci is dependent on the Lutz procedure, a combination of Gram's method with decoloration in nitric acid; whether this special appearance is due to a reaction between the gentian-violet and iodine, and how this peculiarity can be explained.

After numerous experiments with various chemically pure dyes the author discovered that only the pararosanilins, to which gentian-violet belongs, possess the property (when used as stated) of showing lepra bacilli as "coccothrix," while rosanilin, under similar circumstances, presented the same micro-organisms as bacilli. This difference is so constant that by their aid it is always possible under the Microscope to distinguish the two dyes, and this is all the more striking, as between rosanilin and pararosanilin there is only a slight chemical difference, CH₃ replacing H.

The author, furthermore, showed the relation of the iodine preparation

* 'The Dyeing of Textile Fabrics,' London, 1885.

† Dermatol. Studien, 1887, Heft iv., 73 pp.

to these dyes, finding that only between the combinations of simple iodine with rosanilin on the one part, and with the pararosanilin on the other part, do the characteristic differences in the staining of the lepra bacillus exist.

He suspects, therefore, that the iodine in pararosanilin staining completely extracts the dye where it is more loosely associated with the tissue, and where the combination is stronger it unites with it in the tissue. A new dye is therefore formed, which, on account of its slow and difficult extraction, is more suitable to show further differences of the tissues than the simple dye. The methods of Gram, Lutz, and Unna are accordingly to be considered as variations of a general iodine-pararosanilin method.

Extract of Logwood as a substitute for pure Hæmatoxylin.*—Dr. J. Paneth finds that the commercial extract of logwood is a satisfactory substitute for pure hæmatoxylin in staining the central nervous system after Weigert's method. From this extract is made a solution which contains 90 parts water, 10 parts spirit, 1 part dye. Before use it is filtered. To 100 cem. of this solution 8 drops of a concentrated solution of lithium carbonate are added. The celloidin-imbedded sections are placed for twenty-four hours in Weigert's copper acetate solution, then in 80 per cent. spirit; then are stained in the above solution for 18–24 hours at the ordinary temperature. They are next decolorized with the borax and ferro-cyanide solution.

This method, which is practically that of Weigert, gives similar results, but at a much less cost.

Reduction of Chromic Solutions in Animal Tissues corrected by Reoxidation with H_2O_2 .†—It is well known that the brownish-green colour assumed by animal tissues under exposure to chromic solutions is due to a combination of the oxide of chromium (Cr_2O_3) with CrO_3 . There is a partial reduction of the chromic acid in the tissues, resulting in the formation of Cr_2O_3 , which then unites with the remaining CrO_3 to form the compound known as chromic chromate. Dr. P. G. Unna has shown that the greenish colour can be removed by treating the tissues with hydrogen dioxide.

The chemical processes involved are explained in the following manner:—If a solution of chromic acid or bichromate of potassium be mixed with a solution of H_2O_2 , a deep green precipitate of chromoxide (Cr_2O_3) is immediately formed, which combines with the remaining chromic acid to form the intermediate salt (chromic chromate) with a brownish-green colour. If the mixture is left to itself, the process of reduction, after reaching a definite point, changes to one of oxidation, and the chromic chromate is soon reoxidized, leaving the solution yellow as at first. The same phenomenon is seen when (1) sections coloured by chromic acid or bichromate of potassium are placed in H_2O_2 , or when (2) sections treated with H_2O_2 are immersed in the chromic solutions. The sections at once become dark green, then brownish-green, and finally, in the first case yellow, in the second colourless. If the sections, at the moment when the brownish-green colour appears, are removed from the solution and thoroughly washed, the colour of the chromic chromate, which is not unimportant for many histological details, remains fixed.

BABES.—Nouvelle coloration des tissus normaux et pathologiques. (New stain for normal and pathological tissues.) *Bull. Soc. Anat. Paris*, XI. (1886) p. 73.

HAUSEE, G.—Zur Sporenfärbung. (On spore-staining.)

Münch. Med. Wochenschr., 1887, p. 654.

JOSEPH, M., and C. WURSTER.—Über der Metaphenyldiamin als Kernfärbemittel. (On metaphenyldiamin as a staining agent for the nucleus.)

Monatschr. f. prakt. Dermatol., 1887, Nr. 6.

* *Zeitschr. f. Wiss. Mikr.*, iv. (1887) p. 213.

† *Arch. f. Mikr. Anat.*, xxx. (1887) p. 47. Cf. *Amer. Natural.*, xxii. (1887) p. 868.

KRYSINSKI, S.—Beiträge zur histologischen Technik. 1. See Imbedding. 2. Indigo-carmin als Tinctionsmittel. 3. Alauncarmin. (Contributions to histological technique. 2. Indigo carmine as a staining agent. 3. Alum carmine.)

Virchow's Arch. f. path. Anat. u. Hist., CVIII. (1887) pp. 217-9.

WEIGERT, C.—Über eine neue Methode zur Färbung von Fibrin und von Microorganismen. (On a new method of staining fibrin and micro-organisms.)

5 pp., 8vo, Berlin, 1887.

(5) Mounting, including Slides, Preservative Fluids, &c.

Mounting Sections without Cover-glasses.*—Dr. C. Weigert recently showed that celloidin sections could be cleared up with carbol xylol, and as many of these sections were intended to be mounted under the same cover-glass it was found in practice to be somewhat expensive to provide cover-glasses of sufficient size. He resolved to follow in Golgi's footsteps, and do without the cover-glass, but as the Italian method has several inconveniences attached to it he adopted the photographic negative varnish as the substitute for dammar.

After the sections have been cleared up with carbol xylol, the excess of fluid is removed in the usual way with blotting-paper, and a thin layer of the negative varnish is poured on. This dries very quickly. The drying may be accelerated by gently warming the slide, and this must always be done if the layer appears cloudy. When the first layer is dry, another coat is laid on, and so on until the surface remains quite smooth. Three coats are usually sufficient. When finished, the surface may, if necessary, be wiped or washed with water; high powers and even oil-immersion lenses may be used in the examination. In the latter case, a small drop of water must be placed on the surface, and upon this a cover-glass. This method cannot be used for sections stained with the anilin dyes as the carbol xylol destroys them.

Gum Dammar.†—Dr. F. L. James, referring to a paper by Mr. H. Morland‡ (in which he discredits gum dammar on the ground that it is as friable as chalk) says that he has used dammar for several years as a medium for mounting diatoms, crystals, &c.; in fact, to the entire exclusion of Canada balsam, styrax, and all other resinous media, and with perfect satisfaction. It may be used without decolorization by proceeding as follows: Dissolve the dammar in sufficient benzol to give a fluid which will pass through the best Swedish filtering paper. When filtered, evaporate the surplus benzol, and bring the solution to the consistency of treacle. Now add to each ounce of the resultant solution ten minims of the best nut or poppy oil, and shake well. The result will be a "balsam" that will never become brittle, turn red, or become opaque.

Decolorized dammar may be made as follows: Dissolve dammar in benzol, and to the solution (which should be filtered through absorbent cotton or mineral wool) add alcohol of 95% until it no longer throws down a white precipitate. Stir thoroughly, decant the supernatant liquid, and wash the precipitate gum in absolute alcohol. Wash well, mulling the gum while washing, and afterwards rinse with water. Throw the washed gum on a filter and let dry (which it will do in twenty-four hours), after which it should be dissolved in pure benzol (*benzol purissima*, or the crystallizable benzol of Merck), and either allowed to stand a while or filtered. The solution will be as limpid and clear as crystal; but the gum contained in it is excessively friable. This defect is corrected, as in the former instance,

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 209-10.

† Engl. Mech., xlvi. (1887) pp. 184-5.

‡ Journ. Quek. Micr. Club, iii. (1887) pp. 108-14.

by the addition of nut or poppy oil. The refractive index of this gum the author has not accurately determined; but it is so nearly identical with that of crown glass that a bit of the latter substance dropped therein is visible only with the closest scrutiny.

Xylol-Dammar.*—In an article on resinous substances and the preservation of microscopical preparations, Dr. G. Martinotti advocates the use of dammar as the fittest medium for mounting microscopical preparations when the general structure is desired to be brought out. In this respect it is superior to Canada balsam which is most suited for throwing into relief certain parts of a specimen which are deeply stained, such as nuclei, micro-organisms, &c. A suitable solvent for dammar has long been a desideratum, for though Flemming and Pfitzner have produced dammar solutions with turpentine and benzin, the resulting fluids have the fatal fault of losing their transparency in a comparatively short space of time. After numerous experiments, the author finally selected xylol as the solvent, and he found it to possess the necessary qualifications. The medium he produced, xylol-turpentine-dammar, is a white or slightly yellowish fluid which does not affect the anilin stains nor dissolve celloidin, retains its transparency (for nine months at least), and gives a perfect definition of the histological elements. Finely powdered dammar resin and xylol are placed together in a closed vessel, and after some days the clear supernatant fluid decanted off, or the mixture filtered. The clear white fluid is then evaporated in a water-bath to a semi-fluid mass, which is yellowish and resembles Canada balsam. If desired, the mass may be further concentrated, and in this denser condition it does not lose its transparency or viscosity. In practice, however, it is not necessary to proceed further than the semi-fluid condition. To produce a medium suitable for microscopical purposes, oil of turpentine is added. By this addition the microscopical images are rendered more effective than with the simple xylol solution; the medium is less brittle when dry, and also loses most of its yellow colour. The author regrets this slight defect, and thinks it might be obviated if the concentration were carried out in vacuo and not by the aid of heat. In a note the author appends the exact quantities for making the solution. 40 gr. of powdered dammar resin, and 40 gr. of xylol are left for three to four days at the ordinary temperature in a closed vessel and then filtered. The filtrate is evaporated in a water-bath down to about 45 gr., and to this 25 gr. (or even more) of essence of turpentine are added.

The author next refers to some solvents of Canada balsam, chloroform, turpentine, benzin, oil of cedar, and xylol. Chloroform is objected to on account of the yellowness which increases with time. Turpentine decolorizes certain dyes, e. g. hæmatoxylin, and after a certain period bubbles of gas are developed within the preparation. Benzoin is fairly good, but the fluid is rather viscid. Of cedar oil as a solvent the author has no personal acquaintance. Xylol gives fair results, but the colour of balsam dissolved therein is markedly yellow. Safranin and other dyes seem to be injuriously affected by this reagent, which moreover is destructive of certain delicate structures, such as karyokinetic figures.

Oil of lavender produces with Canada balsam an almost colourless fluid; preparations mounted therein are said to be quite elegant, especially those stained with logwood. Some anilin stains, e. g. safranin, are however dissolved by the action of lavender oil, but others retain their brilliancy. The author, however, admits that his experience of this solvent is too short

to give a definite opinion of its value, but he thinks that it will be found to be extremely useful.

Directions for using Prof. H. L. Smith's High Refractive Mounting Media.*—Prof. H. L. Smith gives the following directions:—Use barely enough of the medium to fill in under the cover when the slide is warmed; it does not materially diminish by any subsequent heating.

Boil thoroughly under the cover and until all bubbles disappear on allowing the slide to cool; if any should still remain they may be readily coaxed out by proper application of a small flame.

When the slide is cold the cover should remain firmly fixed; any excess of the medium must be removed by means of a moist cloth or a roll of moistened tissue paper. The cleansing must be thorough; all excess must be removed around the edge of the cover, as otherwise it is liable to act upon the cement or finishing ring. If, after the cleaning, the cover shows metallic stains, do not attempt to clean them off until after the finishing ring is hard. When the excess has been removed around the edge of the cover, gently warm the slide to drive off the small amount of moisture that may have been absorbed during the cleaning. When again cooled apply a protecting ring of asphalt-black, or white zinc, or, perhaps better, if one will take the trouble to make them, a wax ring, punched from the sheet-wax used for artificial flowers. The wax ring is a sure protection, especially for the highest medium, yet the white zinc or the asphalt answers well. In using the wax ring, the heat must be very cautiously applied, so as barely to melt it, following gently around with a very small flame. If bubbles of air are entangled under the ring, touch them with a heated needle-point just before the wax cools.

When the asphalt, white zinc, or wax ring is solid, apply a good coat of shellac dissolved in alcohol. Slides thus protected keep perfectly well. After the ring is firmly set, any metallic stains remaining on the cover may be removed by a piece of tissue paper and moistened with hydrochloric acid.

Section-lifters.†—Dr. W. Y. Cowl advocates the use of section-lifters made of horn. They are in one flat piece, weigh 10 grains, are 3 in. long, and $5/8$ in. wide at the blade, which is square, of about $1/200$ in. thick, and merging into a handle $1/20$ in. thick and $3/8$ in. wide. The blade is smooth, flexible as paper, and pierced with fine holes. It can thus be insinuated beneath a section lying flat on the bottom of a dish and upon removal from the surrounding fluid will allow it to drain away from between the section and lifter. This brings the two into uniform apposition, which is a great desideratum. The perforations also favour the floating of the section from the lifter to the mounting or preparatory fluid on the slide. As horn normally contains grease as well as moisture, it will take oily or gummy media, but must then be confined to use with them. Lifters for water or glycerin must be made of burnt horn, i.e. mostly deprived of fat. In preparing specimens, the lifter is preferably inverted over the slide when loaded with a section, whilst a drop of fluid let fall on the holes in the middle of the blade, loosens the tissue, from which the instrument may then easily be withdrawn. As the horn is transparent, every detail of the section on its under side can be seen.

The use of such a section-lifter naturally suggests a stout bristle instead of a needle. It may be held in a clamping needle-holder, and when so mounted, or even simply tied to a stick, will so far surpass the needle as a means of manipulation that no one who has ever tried it will cease its use.

* Microscope, vii. (1887) pp. 308-9.

† Ibid., pp. 164-6.

"Berry's Hard Finish" as a Cement and Mounting Medium.*—Prof. W. H. Seaman writes that early last winter Dr. Taylor suggested that a varnish known as Berry's hard finish (substantially Zanzibar copal dissolved in turpentine) might serve as a cement. This varnish is in very extensive use for coating wood in its natural colours, in the method now so common, and hence easily got everywhere. Dr. C. T. Caldwell took up the subject, and in the course of mounting a few slides, found he had a material which was not only useful as a cement, but also as an imbedding or mounting substance proper. Since his trials a number have used it, all with the most favourable results. Prof. Seaman has slides showing insects imbedded in it that have cleared up well without any previous preparation. Numerous other mounts have been made by other persons of different kinds, and he "has no hesitation in recommending it for trial as the most promising thing in this line he knows." It is so common it may be obtained at any paint store, and may be thinned with turpentine if too thick. One of its advantages is that it does not precipitate when brought in contact with aqueous solutions to anything like the extent that balsam does.

King's Cement.†—Under the heading "a thoroughly reliable cement," Miss M. A. Booth says that after an extended and critical experience she thinks that the cement prepared by the Rev. J. D. King possesses all the desirable qualities of a universally useful cement. To lovers of the beautiful, King's scarlet or blue cement is pleasing to the eye, while that large class of microscopists to whom such beauty is a blemish will find in his amber cement reliability shorn of any objectionable features. In every instance in which she has known where King's cements have not proved fully satisfactory the fault has been with the user.

In using Mr. King's cements, four points are to be observed:—

- (1) Keep your cement of the right consistency; if too thick, thin it with alcohol.
- (2) Use a Winsor and Newton Rigger brush No. 2; have its handle put through rubber cork, and keep the brush when not in use in a corked vial of alcohol.
- (3) While using the brush wash it frequently in alcohol.
- (4) Use no cement cells until they are *thoroughly dry*.

"Observing these precautions, we have an infallible cement."

HOLDEN, A. L.—A New Material Cabinet.

[“A very artistic and inexpensive material cabinet can easily be constructed in the following manner:—It consists of three tin or wooden boxes, of equal height, with flat covers, varying in diameter from $1\frac{1}{2}$ to $3\frac{3}{4}$ in. Take the largest, and fasten to the bottom a circle of wood or metal, $4\frac{1}{2}$ in. in diameter and $1\frac{1}{2}$ in. in thickness. The projection will form a rest for the vials, which are held in position by a rubber band placed around each box. The next smaller box, $2\frac{3}{4}$ in. in diameter, should be fastened to the cover of the largest, and so on. The interiors of the boxes form a receptacle for packets of dry material. If painted a light colour, the objects in the vials will be easily seen, and when finished, it makes a useful ornament for the microscopist's table.”]

Microscope, VII. (1887) p. 293 (1 fig.).

[MANTON, W. P., and others.]—**Elementary Department. Seventh, Eighth, and Ninth Lessons.** [Mounting media.—Sealing and cements.—Cells.—Cell-building.]

Microscope, VII. (1887) pp. 277-80, 302-4, 337-9.

(6) Miscellaneous.

Crystallization by Cold.‡—Dr. F. L. James makes geometrically perfect crystals in the following manner:—Provide two watch-glasses of nearly equal size and shape, so that they fit snugly into each other. Into one of

* Queen's Micr. Bulletin, iv. (1887) p. 33.

† *Microscope*, vii. (1887) p. 297-8.

‡ *Ibid.*, pp. 166-8.

these pour the liquid to be crystallized, and having warmed the other by passing it through the flame of the lamp or dipping it in hot water, place it immediately on the top of the globule of fluid, letting it settle to place of its own weight. The fluid is thus spread out into a tenuous film between the two watch-glasses. Now place the watch-glasses upon a piece of felt, two or three thicknesses of blotting-paper, or some other non-conducting material, and with a pipette pour on to the cavity of the upper glass a half fluid drachm of rhigoline, benzol, or ether, and blow on it with the lips. As the temperature falls the film of liquid begins to deposit crystals; sometimes this occurs instantaneously, usually it requires about fifteen seconds to a minute to thoroughly cool the glasses. If necessary, the process must be repeated.

As soon as the deposition of crystals ceases take a bit of blotting-paper and pass the edge of it between the glasses to absorb the remaining mother liquor, leaving the crystals nearly dry. The upper glass is then removed and the crystals in the lower glass may be examined at once under the Microscope or collected and washed.

It is presumed that the liquid to be crystallized is in a concentrated state: if not, the small quantity required for this process is easily thickened by placing the glass on a hot slide for a few moments. Where the operation must be repeated, it is best to use a clean glass for each portion, or to carefully remove the crystals resulting from previous refrigerations, since the second crop has a tendency to form around and on the first, thus making masses too large for convenient examination with high powers. The use of the pipette for placing the volatile fluid in the upper watch-glass is recommended, because of the difficulty of pouring small quantities of readily flowing fluids with any exactness, and the consequent danger of overflowing and mixing with the fluid to be crystallized.

Method of obtaining Methæmoglobin Crystals.*—Prof. W. D. Halliburton recommends the following easy method for obtaining methæmoglobin crystals. A few cubic centimetres of the defibrinated blood of a rat, guinea-pig, or squirrel, have added to them an equal number of drops of nitrite of amyl, and the whole is shaken vigorously in a test-tube for a minute or so. As soon as the liquid becomes chocolate-coloured a drop is placed on a slide and covered. In a few minutes crystals of methæmoglobin are formed, and if the edges of the cover-glass be sealed they may be kept unchanged for several months. From guinea-pigs' blood the crystals thus obtained are tetrahedra; from squirrels' blood they are perfectly regular hexagonal plates, as are also those from rats' blood; but in the case of the last there were a few other plates which, in the opinion of Mr. L. Fletcher, are merely variations of the hexagons.

Fearnley's 'Elementary Practical Histology.'†—This book has a feature which is extremely novel in a histological work, viz. it contains an account of the Diffraction Theory (under the head of "Immersion Lenses"), with diagrams illustrating Prof. Abbe's leading experiments. The author has been recommended ‡ to omit this portion in future editions, a recommendation which we hope he will not adopt. His reviewer, like so many histologists, has evidently not appreciated the practical importance of the discussion; but one good effect of the book will, we have no doubt, be to make many practical workers with the Microscope acquainted with one of

* Quart. Journ. Micr. Sci., xxviii. (1887) pp. 201-4.

† Fearnley, W., 'A Course of Elementary Practical Histology,' xi. and 363 pp., 46 figs. (8vo, London, 1887).

‡ Nature, xxxvi. (1887) pp. 481-2.

the most important points in connection with microscopical observation, without a knowledge of which they are continually liable to misinterpret histological structures.

ARLOING.—Un analyseur bactériologique pour l'étude des germes de l'eau. (A bacteriological analyser for the study of germs in water.)

CR. Soc. Biol., 1887, pp. 539-40; *Arch. de Physiol.*, 1887, pp. 273-85.

BISCHOF, G.—Dr. R. Koch's Bacteriological Water Test. III.

Lancet, 1887, II. pp. 516-8.

CARNELLY and T. WILSON.—A New Method for determining Micro-organisms in Air. [Consists essentially in the substitution of a flat-bottomed conical flask for a Hesse's tube.]

Nature, XXXVI. (1887) p. 570; *Chem. News*, 1887, p. 145.

EVANS, J.—Address to Middlesex Natural History and Science Society.

["The water supplied by the companies no longer, I am glad to say, affords so varied a field for microscopical observation as it did some fifty years ago; but for microscopic studies it is doubtful whether there is not fully as much scope for students living in towns as for those who reside in the country."]

Trans. Middlesex Nat. Hist. and Sci. Soc., 1886-7, p. 7.

FABRE-DOMERGUE.—Les Invisibles. Phénomènes les plus intéressants de la vie des êtres microscopiques. (The Invisibles. The most interesting phenomena in the life of microscopic beings.)

120 figs., 16mo, Paris, 1887.

HITCHCOCK, R.—The Biological Examination of Water. II.

Amer. Mon. Micr. Journ., VIII. (1887) pp. 169-71.

JAMES, F. L.—Clinical Microscopical Technology. IX. The examination of Semen.

St. Louis Med. and Surg. Journ., LIII. (1887) pp. 292-4.

PETRI, R. J.—Ueber die Methoden der modernen Bakterienforschung. (On the methods of modern bacteria research.)

Samml. Gemeinverständl. Wiss. Vorträge (Virchow and Holtzendorff), 8vo, Hamburg, 1887, 62 pp.

„ „ Eine neue Methode, Bakterien und Pilzsporen in der Luft nachzuweisen und zu zählen. (A new method for demonstrating and counting bacteria and fungus-spores in the air.)

Zeitschr. f. Hygiene, III. (1887) pp. 1-145.

PEYER, A.—Atlas der Mikroskopie am Krankenbette. (Atlas of the microscopy of the sick-bed.)

2nd ed., xii. and 232 pp., 100 pls., 8vo, Stuttgart, 1887.

SLACK, H. J.—Pleasant Hours with the Microscope.

[*Actinophrys*, *Actinomonas*, &c.]

Knowledge, XI. (1887) pp. 267-8 (4 figs.).

TAYLOR, T.—The Crystallography of Butter and other Fats. I., II., III.

Amer. Mon. Micr. Journ., VIII. (1887) pp. 152-3 (1 pl.), 172 (1 pl.), 190 (1 pl.).

WHITE, T. C.—A Manual of Elementary Microscopical Manipulation for the use of Amateurs.

iii. and 104 pp., 1 pl. and 6 figs., 8vo, London, 1887.

PROCEEDINGS OF THE SOCIETY.

MEETING OF 12TH OCTOBER, 1887, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (THE REV. DR. DALLINGER, F.R.S.) IN THE CHAIR.

The Minutes of the meeting of 8th June last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Bonnier, G., and G. de Layens, Nouvelle Flore du Nord de la France et de la Belgique pour la détermination facile des plantes sans mots techniques. xxxiv. and 307 pp., 2282 figs., and 1 map. (8vo, Paris, n.d.)	Prof. Gaston Bonnier.
Chinese book on Natural History, &c., with woodcut of a Microscope	Mr. Crisp.
James, F. L., Elementary Microscopical Technology. Part I, iv. and 107 pp. and 15 figs. (8vo, St. Louis, 1887),	The Author.
Maskell, W. M., An Account of the Insects noxious to Agriculture and Plants in New Zealand—The Scale-insects (Coccididae). 116 pp. and 23 pls. (8vo, Wellington, 1887)	The Author.
Sachs, J. v., Lectures on the Physiology of Plants, translated by H. Marshall Ward, M.A., F.L.S. xiv. and 836 pp. and 455 figs. (8vo, London, 1887)	The Publishers.
Photomicrographs of Proboscis of Blow-fly, stained vertical section of Human Scalp, <i>Pulex irritans</i> , Liver Fluke of Sheep, Red Earth Mite, and injected Human Brain	Mr. W. Ball.
Patent Microtome	Mr. H. J. Dale.

The President welcomed Mr. C. B. Farwell, Senator for Illinois to the Congress of the United States of America, who was present with his brother, Mr. J. V. Farwell, also of Chicago.

Mr. Crisp called attention to a Chinese book on natural history, having an illustration which represented a Microscope almost identical in pattern to the one from Japan exhibited at the meeting of the Society in May last. It would be remembered that this instrument was much criticised at the time by Mr. Beck, who threw doubts upon its Oriental origin; but it was clear, from the figure given in this book, that the pattern was one recognized in the East as a typical form of Microscope. He was sorry Mr. Beck was not present, so that he might see the illustration.

Prof. M. Thury's note was read, describing a multi-ocular Microscope, which he had designed for facilitating class demonstrations. It had several body-tubes and eye-pieces, the image being thrown into each tube successively by the rotation of a total-reflection prism placed over the objective. The teacher and his pupils could thus view the same object without having to change their seats (*ante*, p. 796).

Mr. Crisp exhibited, in connection with the note, the bi-ocular and tri-ocular Microscopes of M. A. Nachet, and the quadri-ocular Microscope of Prof. Harting.

Mr. J. Mayall, jun., said that, with regard to Prof. Harting's quadri-ocular Microscope, he found that M. Nachet claimed to have made such a Microscope, and to have communicated with Prof. Harting about it in 1854. M. Nachet had recently forwarded a drawing of the particular prism which

he used for the purpose, whence it was clear that the prisms were similar in form, though apparently that of M. Nachet was much smaller than those employed by Prof. Harting, of which Mr. Crisp possessed two. M. Nachet had also sent over a prism such as he used in his tri-ocular Microscope, and it would be seen that it was a very complicated one, the construction of which would probably puzzle many persons. He had also forwarded one of his prisms used in the bi-ocular form. These prisms were submitted for the inspection of the meeting.

Mr. C. D. Ahrens' Microscope, with three body-tubes and three objectives, was exhibited by Mr. Crisp (*ante*, p. 799).

Mr. J. Mayall, jun., said that in devising this Microscope he did not think that Mr. Ahrens had any scientific end in view, his idea merely being to have something which would serve the purpose of three Microscopes in one, to exhibit to the public on festive occasions at Hampton Court and similar places.

Mr. Crisp said that since their last meeting they had had a correspondence with Dr. Van Heurck on the subject of the remarks made at the January meeting by Mr. Mayall and Mr. Beck as to the photographs of *Amphipleura pellucida* made by Dr. Van Heurck, the suggestion being that the background of the photographs had been painted out. Another set of photographs had now been sent over which had not been manipulated, and which, Dr. Van Heurck claimed, showed all he had formerly represented.

Dr. Van Heurck's letter was as follows:—

“Basing himself on what was said by Mr. Mayall at your January meeting, Dr. J. D. Cox stated, at a meeting of the New York Microscopical Society, that my photographs had undergone notable alterations.

As I cannot allow such assertions to pass uncontradicted, casting doubts on the accuracy of my observations, I have sent to New York some further prints of my photographs, duplicates of which I send to you. It will be readily seen that these have not undergone the slightest alteration.

I specially call your attention to the longitudinal lines of the *Amphipleura pellucida*, which are vastly more difficult than the beads. The undulated nature of these striæ, so different to diffraction lines, shows clearly that they are real longitudinal lines.”

Mr. J. Mayall, jun., said he was sorry that Dr. Van Heurck should have objected to his criticism, but he must insist that he was fairly entitled to criticize the photographs which he saw on the previous occasion; and when it was said that no diffraction lines were visible, he could hardly do otherwise than point out that the natural background on which they were said to be projected had been blocked out, leaving the field quite white, and consequently destroying the natural outlines of the diatoms. He considered the photographs to be excellently taken, but he objected strongly to the use of an artificial background, which gave fictitious outlines to the objects. He considered all such manipulations as seriously interfering with the scientific value of photomicrographs.

Mr. Enock's preparation of the Hessian fly, and also of its parasite (*Semiotellus destructor*) was exhibited.

Prof. Bell said of course they all devoutly hoped that the parasite might increase and multiply abundantly. The fly itself seemed of late to have been making as much stir in this country as the Colorado beetle did some years ago. It was a very important matter to know that the adult form

had been discovered in this country where they had only previously found the larva and pupa. He hoped that if any Fellow of the Society should come across this insect, he would make it his duty to bring it forward.

Mr. Swift exhibited a Microscope which, on the suggestion of Prof. Tuson, of the Royal Veterinary College, had been platinized by a new process of plating by platinum which had been lately introduced, and which, as applied to Microscopes, he considered to be a great advantage. The fittings of stages in particular are much affected by the action of corrosive fluids, but this is entirely obviated by the process in question. The square edges are not rounded off, as is the case where nickelled. The platinizing had been done by the Bright Platinum Plating Company, and, according to the manager, the cost was about that of plating with silver.

Mr. Crouch exhibited Dr. Woodhead's Microscope with unusually large stage ($11\frac{3}{4}$ in. by $9\frac{3}{4}$ in.) for examining sections through entire organs (*supra*, p. 1015).

Mr. G. M. Giles's Army Medical Microscope was exhibited, and his description of it read. The instrument was designed so as to be applicable to all the work of the military surgeon in station as well as in camp life, and at the same time to be so portable as to pack into a box 5.8 in. by 3.2 in. by 2.75 in. (*supra*, p. 1012).

Mr. Crisp said it was not usual in that room to call attention to things which might be sent for the purpose of sale; but he thought exception might very properly be made in the case of the drawings of the late Mr. Draper. These drawings had, he believed, never been surpassed, and Mr. Draper's widow would be glad to dispose of them to any Fellows of the Society.

Mr. Beck said he recollected very well these drawings of Mr. Draper, which were certainly the most beautiful he had ever seen. He should, therefore, be glad if by some exercise of their discretion the Council could secure them for the Society. Original drawings had always a special value of their own, and he thought the matter might be referred to the Council to consider whether they could be acquired. In all such cases, where a diligent observer had acquired a power of delineation such as that possessed by Mr. Draper, it was desirable that examples of the results should be in the possession of the Society. He would, therefore, submit to the meeting a motion to the effect that the Council be asked to take the matter into their consideration.

Mr. Deby seconded the motion, and said that in order to assist in carrying out the suggestion, he would be prepared to subscribe to a fund for the purpose.

The President having put the motion to the meeting, declared it to be carried unanimously.

Mr. Deby called attention to the sixth annual report of the United States Geological Survey, dated 1885, but only just distributed, which contains a valuable article by Mr. J. S. Curtis, on the 'Quantitative Determination of Silver by means of the Microscope.' This method of assaying ores of silver is a very considerable improvement upon Plattner's well-known method, and has really practical applications. A new micrometer measuring apparatus is figured, and the mode of manipulation fully described.

Mr. H. J. Dale exhibited a microtome which he had made and patented, the speciality of which consisted in the arrangement for working it with the foot, so that both hands were left free for cutting the sections.

Mr. Crisp said it would be recognized as within the duty of the Society to call attention to any important misstatements in the utterances of eminent scientific men in relation to microscopical subjects, and he desired, therefore, to correct the statement of Sir Henry Roscoe in his Presidential address to the last meeting of the British Association, in which he treated the 1/100,000 of an inch as the limit of visibility with the "highest known magnifying power." The limit should be at least the 1/500,000 of an inch.

The President said that the opinion expressed by Mr. Crisp was quite in accordance with the experience of those Fellows who had worked with the higher powers. He could say that he had himself certainly seen objects which were between the 1/200,000 and 1/300,000 of an inch (*ante*, p. 827).

Col. O'Hara's further note on the 'Motion of Diatoms,' accompanying photographs of *Surirella*, was read as follows:—

"In my first communication on this subject I pointed out the means of movement possessed by *Navicula*, and in my second that possessed by *Cocconeis*. I now send an enlarged transparency on glass and an enlarged print on Eastman's paper, which illustrate that possessed by the *Surirella* form. It appears, therefore, that the means of movement which I suggested as applicable to some forms of the Diatomaceæ is probably possessed by all, viz. an undulating and extrusible membrane."

Mr. P. H. Gosse's paper on 'Twenty-four more New Species of Rotifera,' all British, was brought before the meeting by Prof. Bell, who gave a *résumé* of its contents (*supra*, p. 861).

The President said it gave them great pleasure to receive communications such as this from time to time from Mr. Gosse, who was one of their Honorary Fellows.

Mr. C. R. Beaumont's paper, 'Observations on the Metamorphoses of *Amœbæ* and *Actinophrys*,' was read, in which he stated that he had watched *Amœbæ* change to *Actinophrys*, and the *Actinophrys* afterwards develop into *Diffugia* and *Arcella*. His observations had been made with so much care, and were so detailed and repeated, that he considered he could not be mistaken.

Prof. Bell said that in *Amœba* they had a naked mobile mass of protoplasm, apparently devoid of organs and continually changing in form; in *Actinophrys* there was an organism of definite form, and provided with a number of long, straight processes; whilst in *Diffugia* they had a regular mass of protoplasm provided with a case which it made for itself out of the débris of shell or other materials by which it happened to be surrounded. That an *Amœba* should develop into an *Actinophrys* was a fact which might or might not be proved; but it must be borne in mind that the term *Amœba* was used not only in the strict sense in which one would use the terms *Homo* or *Equus*, but as designating any of a number of similar forms. Any statement, therefore, as to *Amœba* passing into *Actinophrys* stood upon a different basis from that of *Actinophrys* passing into *Diffugia*.

Mr. Badcock said he had seen the paper, as well as some letters from Mr. Beaumont, who had also sent him two bottles of water, which he found to contain a number of naked *Amœbæ*, and also some of the testaceous forms, most of which, however, were empty. He had examined some of the specimens, but had not been able to follow out his observations, for various

reasons, the chief of which was that he did not possess the means adopted by Mr. Beaumont, who had a special slide made for the purpose, which he believed was a very good device. It embodied a method by which he was able to keep the water in constant circulation, and it rotated in a way that enabled him to make his observations continuously. He had asked Mr. Beaumont to come to the meeting to tell them more about the matter, but he was not able to do so. He promised, however, to exhibit his apparatus at a future meeting. In a further letter, Mr. Beaumont gave an account of an observation made of a *Euglena* found inside an *Actinophrys*, which, he said, had been taken in during the *Amœba* stage. In looking over some old notes he had found a drawing, made in March 1880, which seemed to correspond with one of the stages which Mr. Beaumont had called *Amœba actinophrya*. Mr. Beaumont had evidently worked very hard, and he thought great interest should be taken in what he was doing. By their next meeting he hoped to have some additional particulars.

Prof. Stewart thought there was very little doubt that these organisms existed under a variety of forms, and that there was nothing improbable in the idea that in *Diffugia* there may be an amœboid state, though there was nothing in the drawings which showed the characters of such special forms. That certain species of *Amœbæ* had more or less globose or spinous forms was also undoubted; but these were in structure very distinct from *Actinophrys*, in which one of the most marked features was the separation of the body into two layers, with rays of a somewhat more dense structure running from the central mass, and giving support to the outer layer. He did not recognize any such indications of complexity in Mr. Beaumont's drawings, and if these were absent, the organisms would not agree with the known characters of *Actinophrys*.

Prof. Bell referred, in connection with the paper, to Dr. Bastian's 'The Beginnings of Life.'

Mr. Hardy said that the second figure reminded him of an observation he once made of an *Actinophrys* being evolved from what is sometimes called *Acineta grandis*, which before separation would have a very similar appearance to this figure. This acinetan is developed from amœboid matter of varying shapes, which, to one not acquainted with their appearance, might be mistaken for *Amœba diffluens*. As *Arcella* and *Diffugia* may be developed from *A. diffluens*, the two *Amœbæ* might have been in the same trough, and the three forms are thus accounted for.

The President thought they were all prepared to admit that a fact must not be in any way disregarded because it was extraordinary, but he was quite convinced, after reading Dr. Bastian's book, that all such matters must be put into the hands of those who were specially skilled in determining the nature of such organisms. When Dr. Bastian's work was first issued, the reviewers considered it a very extraordinary book, and worthy of attention; but when experts examined the contents in detail, it was shown that the observations relied upon were false, and therefore the conclusions utterly failed. He did not pretend to say that the observations in the paper before them were false also; but he did not think the author could object to the same kind of tests being applied to them. They would be content to wait until next year, when the organisms could again be found, to see whether they were so or not.

The following Instruments, Objects, &c., were exhibited:—

Mr. W. Ball:—Photomicrographs.

Mr. Bolton:—*Ceistes Janus*.

Mr. Crisp:—(1) Nachet's Bi-ocular Microscope; (2) Nachet's Tri-ocular

Microscope and Prism; (3) Harting's Quadri-ocular Microscope; (4) Ahrens's Tri-ocular Microscope; (5) Reichert's Mechanical Stage.

Mr. Crouch:—Dr. Woodhead's Microscope, with large stage.

Mr. H. F. Dale:—Microtome, with treadle.

Mr. Enock:—Hessian Fly and its Parasite.

Mr. G. M. Giles:—Army Medical Microscope.

Dr. H. Van Heurck:—Photomicrographs of *Amphipleura pellucida*.

Col. O'Hara:—Photographs of *Surirella*.

Mr. Swift:—Platinized Microscope.

New Fellows:—The following were elected *Ordinary Fellows*:—

Messrs. J. G. Grenfell, F.G.S., W. D. Gunn, C. B. Holland, John Rutherford, J.P., and Edward F. Underwood, M.D.

MEETING OF 9TH NOVEMBER, 1887, AT KING'S COLLEGE, STRAND, W.C.,
THE PRESIDENT (THE REV. DR. DALLINGER, F.R.S.) IN THE CHAIR.

The Minutes of the meeting of 12th October last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

From

Nägeli, C., and S. Schwendener, The Microscope in Theory and

Practice, translated from the German. xi. and 382 pp., 210 figs.

(8vo, London, 1887) The Publishers.

Dr. H. Van Heurck's letter was read, in which he expressed himself satisfied with the result of the discussion at the last meeting relative to his photomicrographs of *Amphipleura pellucida*.

Mr. E. M. Nelson said he had several matters to bring to the attention of the meeting. The first was a suggestion for supplying a want which many had felt of a really good achromatic single lens or loupe for microscopic purposes, of 1/2 in. focus. There were, of course, many such made, and he believed he had tried all, including the achromatics of Steinheil, but he had found them all open to one objection or another. He had, however, found that the want was met by a Seibert No. III. objective having its adapting screw removed. This, when used as a simple lens, formed the best loupe possible. The brasswork might be further turned down in a lathe, and the combination mounted like a Coddington.

Mr. Nelson further said that having lately obtained an improvement in optical power, he had been able to do a little more in the matter of resolution, and one of the first objects he tried was striped muscular fibre, which, as was well known, offered a good many complexities. In the early days of microscopy a muscular fibril used to be represented as a series of light and dark bands, the dark band being about twice the diameter of the white band. In 1853 Messrs. Huxley and Busk discovered a dark stripe in the middle of the bright band, and subsequently Hensen placed a similar darker stripe in the middle of the dark band. With his latest optical

appliances he had been able to see a faint white stripe on either side of Hensen's dark stripe. The sequence of the eight stripes is as follows:—A white stripe. Huxley and Busk's dark. White. Dark. Nelson's light. Hensen's dark. Nelson's light. Dark. He estimated the diameter of these stripes to be all equal. In a muscular fibril of a pig he found its diameter to be $1/11,500$ in., and the length of the pattern $1/11,000$ in. Therefore the diameter of the stripes may be estimated as about $1/88,000$ in. Although he saw evidences of longitudinal breaking up, he could see nothing of Schäfer's beads. There were beads visible such as had been described by some observers, but he considered that these were the result of bad resolution causing the breaking up of the fibres. It was curious to note that with objects of this character some eyes seemed as if they always would see beads.

The third point noticed by Mr. Nelson was the note which appeared in the 'English Mechanic' of November 4th on Mr. Francis' method of improving definition of such an object as *Amphipleura pellucida* by using the analyser. He had tested the plan, and found that it did intensify the resolution in a very marked degree. It did not resolve anything which the objective could not resolve otherwise, but it certainly did strongly intensify it (*supra*, p. 1033).

Mr. Crisp said that the increased effect might be due, as was frequently the case, to an alteration in the intensity of the light. He should therefore like to see if the same effect could not be produced by altering the light in some other way than by using the analyser.

Mr. Nelson said he had tried altering the light, but it certainly had not the same effect.

Mr. Powell said he had also tested the use of the analyser, and found there could be no doubt as to the definition being improved by it; it was also certain that the same definition could not be obtained by reducing the light in other ways.

Mr. Nelson said he had tried all the most delicate tests, but he found an advantage was gained only by oblique light and in a particular direction.

Mr. Crisp inquired whether in the rotation of the analyser certain spectra were found to be shut off?

Mr. Nelson said the analyser was large enough to include the whole of the spectra in every position. He could, however, tell what was the best position by the strength of the green.

Mr. C. Beck suggested that a tourmaline should be tried, so as to see if the effect was exclusively due to polarization.

Mr. E. M. Nelson also exhibited and described a new portable Microscope made by Messrs. Powell and Lealand from his drawings (*supra*, p. 1013).

Mr. J. Mayall, jun., said he was glad that Mr. Nelson had interested himself in the design of so small an instrument, for a want had often been felt of such a Microscope. Generally speaking, a "miniature" Microscope was a mere toy. But here, he thought, Mr. Nelson had added substantially to the stock of working apparatus. The convenience of a good portable Microscope was unquestionable, and would doubtless be largely appreciated by microscopists. The arrangement of the lamp did not strike him favourably. He thought that if the instrument had to be handed round to a class or at a meeting, the lamp would be found inconvenient, if not dangerous. If he might make a suggestion for the improvement in the

mechanism of the new Microscope, it would be in the direction of strengthening some of the parts which seemed rather too weak. It was a vital point to have the optic axis exactly at right angles to the stage, but he feared the cross-arm support of the body-tube was very slight, and would be easily bent in the hurry of setting up or packing away. The attachment of the body-tube to the cross-arm seemed to him defective, and reminded him of some of the least successful of previous constructions. The want of a fine-adjustment might be met to a great extent by the application of a smooth-working draw-tube, as in Swift's Miniature Microscope.

The President said he must express his agreement with Mr. Mayall's suggestions for the improvement of the Microscope. Speaking after much experience in giving class demonstrations with the Microscope, he should consider a paraffin lamp was a dangerous thing to use in a class, in the manner shown, amongst a number of youths, who were not always particularly careful. He thought, if used in that way, some less dangerous oil or some other source of artificial light should be provided.

Mr. Nelson also exhibited and described the new photomicrographic camera, designed by Mr. C. L. Curties and himself. He also exhibited a negative of the proboscis of the blow-fly, which, he thought, would bear the closest examination (*supra*, p. 1025).

Prof. Crookshank said that he should like to examine the apparatus a little more closely after the meeting. He felt much obliged to Mr. Nelson for introducing a cheap and efficient method to their notice. He was himself more and more impressed with the value of photomicrography, and therefore welcomed every additional aid to its extension. So far as he could judge, this apparatus was simple, and enabled the process to be carried on with very little loss of time. This alone would be a great gain to pathologists who did not want to perform feats, but to get the greatest accuracy of detail recorded in as little time as possible. He thought that, especially with regard to bacteriology, the results obtained by photography had not been simply to obtain artistic pictures. Koch photographed the flagella of some of these minute organisms, and in this way obtained demonstrations of the existence of the flagella, which had not been believed in by many. He should like to say that at the *Conversazione* on the 23rd inst., he proposed to throw upon the screen a number of photographs of bacteria, to show that the results obtained by photography might be used for the purposes of teaching. He did not say that in all cases the results gave pictures as sharp as could be desired, but whilst it had been stated that one reason for disbelieving in the value of such researches was because they showed no morphological differences, he thought he might safely leave those to judge of the matter who would see what he proposed to show them on the 23rd.

Mr. Nelson further exhibited a new eye-piece which he had devised (*supra*, p. 928).

The President said that, as their time was already so far advanced, they must omit some of the minor matters on the programme for the evening, in order that they might hear Mr. Beaumont, who had come up to London to give them an account of his observations on the development of *Amœbæ*.

Mr. C. R. Beaumont then exhibited and described his new form of slide for observing living organisms, and read a paper in which he claimed to have observed the development of an *Amœba* into an *Actinophrys*, and then into a *Difflugia* and an *Arcella*.

The President said he was quite sure that the Fellows were indebted to Mr. Beaumont for taking the trouble of coming so far to present to them a detail of the facts as they appeared to him during the course of his observations. Whilst they should be most unwilling to do otherwise than give their best thanks to Mr. Beaumont for his paper, yet, for his own part at least, he should also be most unwilling to pronounce any opinion at present upon the subject, but thought rather that they should wait until the time of year arrived, when it would be possible to repeat the experiments in accordance with the ideas expressed by Mr. Beaumont. The statements made in his paper were so remarkable that it was not scepticism, but rather the exercise of a true scientific spirit to suspend judgment upon the question until it could be subjected to the test of experience. Those who had made observations upon minute forms, knew quite well, that though a slide might be good in all respects, yet the water from a still pond sometimes contained organisms which were capable of passing through the tube in their germ forms and of subsequently developing when the conditions were favourable. In one of the earlier volumes of the 'Monthly Microscopical Journal'—that for 1873—there occurred a description of one of the monads, in which exactly what Mr. Beaumont had stated appears to have been observed. In this case the monad, after moving about in the same manner, became amoeboid. By-and-by two were seen to blend, and then, from this, spore-like bodies were seen to emerge. It was, he thought, quite possible that Mr. Beaumont might have interrupted this process, and also have introduced from extraneous sources that which might lead to considerable confusion. There were at least sufficient difficulties in the way to render it a matter for the exercise of caution. It should be distinctly borne in mind, however, that in this paper it was not the life-history of a single form which was described, but the transformation of one well-known form into another, and this again into a third and a fourth.

Mr. Beaumont, in reply to questions, said that the water which he used to fill up the slide was tap water; this was very good water in his part of the country. The water flowed from one reservoir to the other by the fall given to it by the inclination of the stage, and when it had all run through it was only necessary to rotate the stage, and the process would repeat itself from the other end.

Professor Bell, in reply to the President's request for his opinion, said that he had nothing to add to the remarks which had already been made by the President, but would merely repeat in other words that in these matters they must have the most absolute evidence of isolation in the case of the organisms under observation; if there was any doubt about that, of course the experiments must be repeated.

Mr. Beaumont said that the five ponds he had mentioned in his paper contained a large number of organisms, and he should be very glad to send up a supply to any one who wished to have some.

Mr. Badcock said, that at p. 225 of Mr. Saville Kent's work on Infusoria, there was an account which to a certain extent corroborated the observations which the President had just quoted from the Journal. In this he described and illustrated the direct metamorphosis of a flagellated zooid into an organism like *Actinophrys*. A similar life-history had also been worked out by Mr. Fullagar, who also described *Actinosphaerium*. His own view was that Mr. Beaumont had, as he claimed, traced the life-history of *Amœba* from a flagellate monad to an ordinary *Amœba*, thence into *Actinophrys*, and thence again into *Diffugia* and *Arcella*, the tremulous sarcode bursting from the cyst and dispersing a number of granules. Now these granules, he presumed, would produce the original flagellate monad,

but this had to be proved. If they looked at the slide with a high power they would see that these granules were in motion, and it was very important that the rest of their history should be watched, and this link in the chain supplied. If that could be done, then he thought they had a very important discovery before them.

Mr. E. M. Nelson said he had very little knowledge of organisms of this class, but if any opinion from a brass-and-glass point of view was of any value, he might say that he was examining some monads in Scotland a short time ago, and was induced to watch them because they behaved in such a very extraordinary way, and in the course of his observations he saw the very same things take place which Mr. Beaumont had described—one of the organisms shot off its flagella, and then burst exactly in the same way.

Mr. C. Beck asked if any attempt had been made to isolate these organisms in the same way as had been done in the case of Bacteria?

The President said that, as already mentioned, observations exactly corresponding to those made by Mr. Nelson were not at all uncommon if made upon the organisms found in putrefactive fluids, but in order to be of value, they must be correlated. In the case before them it must be remembered that the claim was made that from a unicellular organism a more complex organism had directly arisen. The subject was very valuable as a basis of work, and no doubt there were some amongst them who would go very heartily into that work when Mr. Beaumont was again in a position to supply them with the material.

Mr. H. B. Brady's paper, "A Synopsis of the British Recent Foraminifera," was communicated to the meeting by Prof. Beli (*supra*, p. 872).

The President was sure it would be in full accordance with the feelings of the Fellows to accord their hearty thanks to Mr. Brady for this very valuable contribution to the literature on the subject. A Synopsis of British Foraminifera brought down to date was much required.

Mr. Crisp said he had been asked to mention to the meeting that Prof. Smith's collection of diatoms was in the hands of Dr. Maddox for disposal on behalf of the widow.

The President called attention to the *Conversazione* which had been arranged for the 23rd November, and said that they would no doubt be glad to notice that the usual programme was to be supplemented by an exhibition by Prof. Crookshank in his Bacteriological Laboratory, which would be of the greatest interest.

The following Instruments, Objects, &c., were exhibited:—

Mr. Beaumont:—(1) Life-slide; (2) Organisms illustrating his paper.

Mr. Bolton:—*Nitella* sp.?

Mr. Crisp:—Martin Microscope with fixed mirror.

Mr. Nelson:—(1) Portable Microscope; (2) Photomicrographic Apparatus with square Camera; (3) New Eye-piece; (4) Achromatic Loupe.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. A. J. Acheson, Ph.D., M.D., F. T. Andrews, Ph.D., M.D., J. W. Blagg, Edward T. Browne, C. S. Jeaffreson, F.R.C.S., Andrew Pringle, and Rev. C. H. Rowley.

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(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

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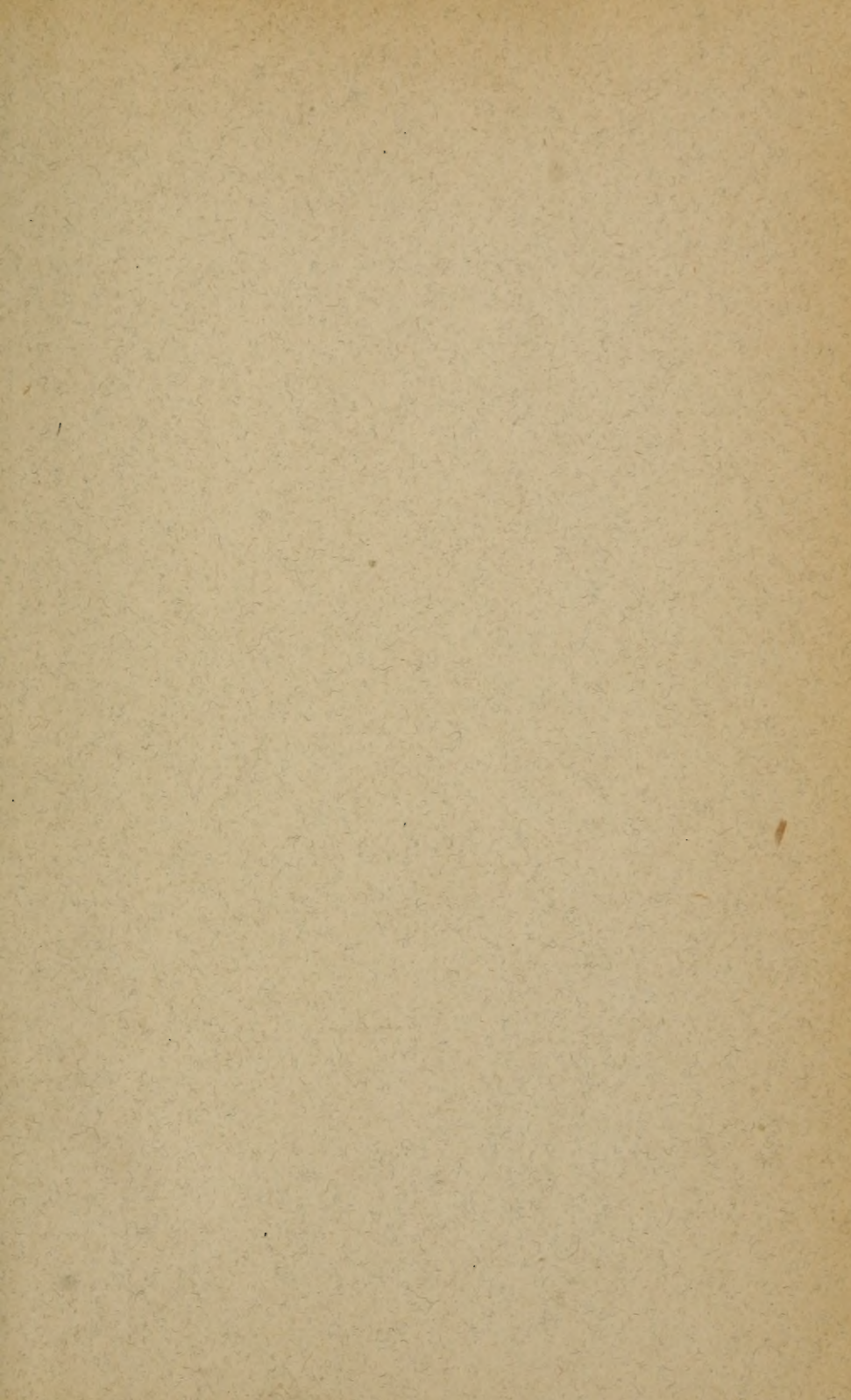
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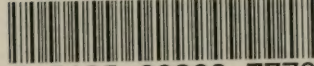


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